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**Speed Choice, Speed Preference and Risk Perception:
Relevance for the Problem of Speed Variability in Traffic**

A thesis
submitted in fulfilment
of the requirements for the degree
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Abstract

Fifty percent of drives have been found to frequently violate speed limits (OECD/ECMT, 2006), and speed limit compliance appears to depend on the perceived credibility of a road's speed limit (Goldenbeld & van Schagen, 2007). Credibility of speed limits, in turn, appears to be determined by the match between drivers' speed preferences and the design of the road (Goldenbeld & van Schagen, 2007). Yet, a challenge has been that not all drivers' prefer the same speeds, and individual differences with regards to speed preference lead to speed variability and speed conflicts in traffic (Elvik, 2010). The aim of this thesis was to explore whether the speed drivers like to drive when motivated by different driving goals (speed preference) correspond to the speeds that they actually drive on those same roads (speed choice). Additionally, this thesis sought to explore the relationship between speed preference and risk perception. Data was collected in two ways, from a speed gun and from a questionnaire. The speed gun collected on-road measures of driving speeds on seven different roads, while the questionnaire collected measures of drivers' self-reported speed, speed preference and risk perception. For the speed preference measures, participants were asked what speed they would choose on a given road when: 1) motivated by safety, 2) considering fuel savings, or 3) motivated by fun, and additionally 4) what speed they usually drove on the road. In total 200 drivers were interviewed at five different parking lots, and they referred to the seven roads that were sampled with the speed gun. The results indicated that speed preference helped to explain actual driving speeds. More specifically, drivers' different driving goals and their large individual differences with regards to speed preference corresponded to different speed choices. No relationship was found, however, between drivers' speed

preferences and their risk perceptions. The results are discussed with regards to implications for the problem of speed variability in traffic.

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1 Literature Review

1.1 Theoretical Background and the Issue at Hand

The complexity and prevalence of driving behaviour makes the traffic environment a natural and rich arena in which to study psychology. Driver behaviour does not merely refer to a driver's ability to aim and accelerate, so to speak, but encompass all driving related behaviours (Östlund, Nilsson, Törnros & Forsman, 2006). It has been said that: "Driver behaviour is what the driver actually does given the limitations and constraints and given the driver's needs, motivation, and goals that can be achieved through the driving task" (Shinar, 2008, p. 54-55). Thus driver behaviour, in addition to describing observed behaviour (i.e. a foot pressing on the accelerator pedal) also describes the influence of a driver's internal functioning (i.e. motivation). It can therefore be said that driver behaviour includes a driver's cognitive and affective, conscious and unconscious, internal as well as external processes, and the interactions between all these. Such a statement place this thesis in what Miller (2003) would refer to as cognitive sciences. The theoretical interest of this thesis is thus in a broad sense to better understand the workings of the mind; and moreover to understand how this influence actual driver behaviour. The influence of a drivers' psyche on his or her behaviour in traffic is of key importance, as there currently is a very urgent and unsolved problem associated with driver behaviour; namely crashes.

Everyday a great number of injuries and fatalities result from crashes, and road crashes have lately received special attention from the World Health Organization, which reports that on a global yearly basis the number of people who die in or from road crashes is over 1.2 million. In addition to that figure, the

number of people who are left with injuries or disabilities is estimated to be tens of millions (WHO, 2013). In a large report released by the World Health Organization in 2011 in preparation for the so-called 'Decade of Action for Road Safety 2011-2020' as declared by the UN General Assembly, it was made known that the estimated road traffic fatality rate in New Zealand was 9 in 100,000 (World Health Organization, 2013). This estimation was based on a figure from the Ministry of Transport (2011), who reported that there were 375 road fatalities in New Zealand in 2010.

While it is not known how many of the above crashes were speed related; there are some types of crashes that are likely related to, or at least partially influenced, by speed. 'Loss of control', for instance, may in some cases be caused by speeds that are excessive with regards to the road conditions, or excessive with regards to the mental capacity of the driver (Fuller, 2011). Of the 375 road fatalities in New Zealand in 2010, 172 fatalities were classified as 'loss of control' or 'off road crashes', and of these, 130 occurred when the vehicle was cornering (Ministry of Transport, 2011). Furthermore, with regards to speed, and in particular the differences between vehicle speeds, it is likely that 'overtaking or lane change crashes' and 'rear-end collisions' have a particular relevance (Bar-Gera & Shinar, 2005). A more detailed look at the 2010 statistics from New Zealand, show that overtaking or lane change crashes in addition to causing 16 fatalities yielded 77 serious injuries and 406 minor injuries. Furthermore, rear-end collisions in addition to causing 9 fatalities yielded 69 serious injuries and 1443 minor injuries (Ministry of Transport, 2011).

1.2 The Causes of Crashes

The causes of road crashes are many, and crashes have often been categorised in order to understand why they happen. Armsby, Boyle and Wright (1989) categorised the causes of crashes into three groups: behavioural, vehicular, and environmental. By identifying the causes of crashes in these three groups, it was expected that the solution to reducing crash rate could also be found there. For example, perhaps by means of increasing the safety in the road environment, or by designing safer vehicles, or in training drivers, one can reduce the number and severity of crashes in traffic. However, while news articles may often report the causes of crashes simply, such as: “Slippery roads caused by a slight overnight drizzle and sub-zero temperatures led to a number of serious crashes on city streets, Thursday morning” (Shaw Media Inc., 2013), the causes of crashes are often quite complex. Because of the complexity associated with crashes the term risk has been a helpful alternative for describing why crashes sometimes happen yet other times do not. For example, rather than saying that slippery roads cause crashes a more accurate statement would perhaps be to say that slippery roads are risky.

Risks have also been categorised for the purpose of developing appropriate safety interventions. In one model it was proposed that all driving risks can be reduced to one of the following nine types: 1) kinetic energy, 2) friction, 3) visibility, 4) compatibility, 5) complexity, 6) predictability, 7) individual rationality, 8) individual vulnerability, and 9) system forgiveness (Elvik, 2004). In the example of the slippery road, friction (or lack thereof), would be one of the risk factors possessed by the slippery road according to this model. Thus, by

increasing the friction (i.e. by means of studded tyres), one could say that, *ceteris paribus* the particular risk of sliding off the road has been reduced.

In relation to traffic safety, risk has been defined as the likelihood or probability of a crash, multiplied by the possible damage or negative consequences associated with that crash (Elvik, 2004). Accordingly, risk has much to do with probability estimations of possible consequences. The question then becomes trying to estimate what the likelihood is of various crashes; a question which is exceedingly hard to answer. Trying to estimate the riskiness of speed, for instance, is very difficult, as “the exact relationship between speed and crash rate depends on a large number of different factors” (Aarts & van Schagen, 2006, p. 224).

Could it be that the unknown probabilities associated with various risks on the road also help explain risk taking behaviour in traffic? One man, whom subtly hinted at how an unknown probability can foster risk-taking, said: “If risk were exclusively of the nature of a known chance or mathematical probability, there could be no reward in risk-taking” (Frank Knight in Liberty Fund, 2000, p.22). This statement eloquently underlined that sometimes (in the face of uncertainties) risk-taking pays off. However, in the context of traffic safety one could be tempted to ask: what rewards are worth the risks when seemingly so much is at stake? The answer to this question is multifaceted, and how risk perception theories answer this question will be presented shortly. First, it suits to introduce one particularly debated risk factor, and the one that is under investigation in this thesis, namely speed.

1.3 The Role of Speed in Traffic Safety

Traffic crashes are a worldwide problem, and speed has been seen by many to be at the centre of the problem (Goldenbeld & van Schagen, 2007). It has been pointed out that wrong or excessive speed leads to crashes (Wåhlberg, 2006). In an extensive review from Aarts and van Schagen (2006) it was confirmed that the published literature resoundingly stated that both high speeds and large speed variability (speed differences between vehicles) is risky. As a result they concluded that “Speed is an important factor in road safety” (Aarts & van Schagen, 2006, p. 215).

The relationship between speed and traffic safety was demonstrated mathematically, in an equation known as the Power Model (Nilsson, 2004; Elvik, 2013). The Power Model demonstrated that as mean speeds increase both the severity and frequency of crashes also increase exponentially (Elvik, 2013). This led to the suggestion that the relationship between speed and crash rate (and severity) represents more than a mere statistical correlation, and that it in fact represents a causal relationship (Elvik, 2005). Drivers may have been acquainted with this suggestion through the slogan: “speed kills” (Navon, 2003, p. 361). That there would be a relationship between high speed and high risk has according to some been an obvious fact, as drivers at high speeds will travel a longer distance while perceiving, deciding, and taking action (i.e. braking); not to mention that high speeds are also associated with higher crash impacts (Navon, 2003). Speed is most risky in its combination with mass, which is referred to as kinetic energy and which becomes dangerous when released suddenly such as in an impact (Elvik, 2004). This aspect of speed was what led one man to somewhat famously object to the above slogan, saying that: “Speed has never killed anyone. Suddenly

becoming stationary, that's what gets you" (Jeremy Clarkson in Good Reads, 2013). The risks associated with kinetic energy, was pointed out and put plainly by one researcher who said that: "Vehicles weighing 1000 kg or more are obviously dangerous when moving at speeds of 20-30 m/s" (Summala, 1988, p. 493). While kinetic energy can be dangerous, it has also been pointed out that kinetic energy only poses a risk and does not cause harm as long as it remains under a driver's control (Elvik, 2004). The relationship between crash risk and drivers' vehicle-control was also addressed by Fuller (2011) who said that collision avoidance is primarily the result of drivers' controlling their vehicles. This relates to the Power Model's second point: that crash rate goes up as speed increases. To explain that relationship, Navon (2003) suggested that heightened crash frequency is related to limitations in driver ability. For example, when travelling at high speeds a driver will cover a longer distance while making a decision than when travelling at low speeds, consequently making a crash more likely. In other words, though a driver does have the controls necessary to steer a vehicle away from a crash, at high speeds that driver also has less time to perceive and react to hazards, and to execute the necessary controlling actions.

Speed variability, or speed dispersion as it is sometimes known (Arts & van Schagen, 2006), refers to the spread of speeds between vehicles. Whereas the speed of a vehicle is normally measured by a speedometer as a quantity relative to the ground, speed variability measures the speed of a vehicle as a quantity relative to other vehicles traveling on the same road. When two or more vehicles are traveling at very different speeds the speed variability is large. When speed variability is small, drivers are travelling at homogeneous speeds. Hence, the counterpart of speed variability is speed homogeneity, sometimes also referred to

as speed harmony (Li, Wang, Wang & Liu, 2010). Speed variability has been found to increase riskiness in traffic situations (Van Nes, Brandenburg & Twisk, 2010), and as was seen in the review by Aarts and van Schagen (2006), speed variability corresponds to higher crash rates. One way in which speed variability increases the risk of a traffic situation is by leading drivers to move more often from one lane to another (Lipshtat, 2009), and lane switching is shown to be a crash prone type of interaction between drivers on the road (Navon, 2003). Speed variability has also been found to increase in already dangerous situations (van Nes, Brandenburg & Twisk, 2010), and therefore add more risk to already risky situations. It has been said that speed variability can produce dangerous interactions (such as frustration, tailgating and hazardous overtaking) between drivers who are intent on driving at different speeds (Navon, 2003).

Navon (2003) called the riskiness associated with speed variability paradoxical. The paradox lies in this; whereas high speed limits on the one hand have been found to be risky (Elvik, 2004), low speed limits have on the other hand have been found to increase speed variability. Navon (2003) hypothesised that low speed limits increase speed variability because they increase the difference between the prescribed speed and intended speed. For example, if many drivers consider a speed limit to be too low they may violate it while other drivers comply with it. When there are large speed differences between those who violate the speed limit and those who comply with it, risky situations are likely to occur. This point is related to the concept of speed limit credibility, which will be introduced shortly. First, a question that remains unanswered so far is this: when so much literature reveals the riskiness not only of speed variability but also of high speeds, why do many drivers seemingly risk it?

1.4 Why do People Speed?

With so much research revealing the riskiness of high speeds, and when a well-known slogan has let many drivers know that speed even kills, one might ask why so many drivers seem to ignore these warnings by violating speed limits every day. Why do drivers seemingly put so much at risk by driving fast? Two theories of risk perception have taken two different approaches to answer the perhaps puzzling occurrence of risk taking (particularly speed) in traffic. These theories are the Zero-Risk Theory (Näätänen & Summala, 1974; Summala, 1988) and the Risk Homeostasis Theory (Wilde, 1986). While these two classic risk perception theories do not agree on the how risk perception influence speed, they both share the view that risk perception does influence speed.

The Zero-Risk theory held that drivers' experience of risk influence their decision making and thus also their behaviour in traffic (Näätänen & Summala, 1974). For example, according to this theory drivers would not drive faster than what they feel safe doing because the drivers' feeling of risk would moderate the speed they select. In answering the question of why drivers speed, the Zero-Risk theory proposed that drivers speed because they are motivated to do so (Summala, 1988). "Speed provides the outlet for a multitude of different driver motives. Speed, as such, is motivating, and higher speeds mean shorter travel times" (Summala, 1988, p. 493). While the theory could give an explanation for drivers' high speeds, it also held that drivers most of the time does not feel at risk (Näätänen & Summala, 1974).

The Risk Homeostasis theory proposed a somewhat different relationship between drivers risk perception and their speeds. The Risk Homeostasis theory proposed that drivers increase their risky behaviour (i.e. increasing speed) in order

to retain an individually preferred target level of risk (Wilde, 1986). In this theory drivers' risk perception was seen as regulating driving speeds so that an optimal target level of risk would be maintained. The theory furthermore proposed that the level of risk that drivers will accept is determined by the trade-offs between costs and benefits (Wilde, 1986). For example, reaching a destination more quickly could be a benefit of selecting a high speed. Such a trade-off, or utility assessment of risk, re-introduce the role of one of the risk factors mentioned earlier, namely 'individual rationality' as influencing drivers' choices of speed (Elvik, 2004).

That rational thinking and utility assessments may influence drivers' selection of speed raise the topic of: why do drivers drive at the speeds that they do? This is a topic which has often been referred to as drivers' speed choice. Speed choice has been a popular variable in much of traffic safety research (Wåhlberg, 2006). However, while it has been a popular variable, it has not necessarily been entirely clear what is implied by it. Wåhlberg (2006) therefore queried how (and why) should speed choice be measured?

Speed, in relation to traffic, is relatively easy to define, it is simply a vehicle's rate of motion (Oxford University Press, 2013; speed, n), and is often quantified as meters per second (m/s) or kilometres per hour (km/h). Choice has been eloquently defined as the act of preferential determination between varieties (Oxford University Press, 2013; choice, n); implying, at least at face value, that a certain force of will-power is being performed when a choice is being made. Based on the two above definitions of 'speed' and 'choice', one could suggest that a driver's 'speed choice' refers to his or her decision to travel at a selected rate of motion. Or in other words; that drivers at will decide what speeds their vehicles travel at. Such a definition of the term speed choice may be okay, but it may also

be insufficient on a theoretical level, as it does not explicitly state whether or not drivers' speeds are the result of conscious moment-to-moment decisions. What support is there in the driver behaviour literature, for the notion that speed is a rational and conscious choice?

1.5 Drivers' Speed Choices

The answer to the question, do drivers choose their speed, is probably on one level, yes. Drivers do at least have the controls necessary to influence the speed of the vehicles that they are driving. The point raised into question here, is not so much whether a driver operates the vehicle he or she is driving, but whether speed is the result of rational decision making, and a deliberate choice. In other words, do drivers consciously choose their speed moment to moment? The following theories may lend support to the notion that drivers do consciously choose their speed moment to moment.

The hierarchical model held that driving involves three levels; a strategic (planning) level, a tactical (manoeuvring) level and an operational (control) level (Michon, 1985). This model implies that drivers at least on one level choose their speeds. The hierarchical model proposed that a strategic level involves general plans that take a long time; a tactical level involves controlled action patterns that take seconds; and an operational level involves automatic action patterns that only take milliseconds (Michon, 1985). Östlund et al. (2006) used Michon's hierarchical model to show how it could describe drivers' speeds as a choice at all three levels. Their example described the scenario of a driver with a goal to reach a destination quickly: On a strategic level, the driver may choose a high speed route, aim at driving fast, and accept high risks. On a tactical level, they may

tailgate other vehicles, cut curves, drive on a yellow light, and generally drive fast. On an operational level, their lateral position may vary, and so will their speed. In light of this example, it seems implied that a driver's fast speed can be greatly influenced by choice, which could support the notion that on one level, speed is a deliberate choice, as it was suggested that: "On the tactical level, driving behaviour is characterised by choice of speed" (Östlund et al., 2006, p. 12).

The task-capability interface (TCI) model was put forward by Fuller (2005), and it was developed to be a general theory of driver behaviour integrating many other driver behaviour theories under the banner of task difficulty. Fuller (2005) proposed that task difficulty had a greater influence on drivers' speeds than what for example risk perception had. According to Fuller (2005) driver behaviour was influenced by the maintenance of safety margins, such as headway distance to other vehicles, and that these margins were kept because they would reduce the difficulty and mental workload of the driving task. With regards to speed choice, the theory seemed also to suggest that speed is a cognitive choice, as for example seen in the following statement: "Speed choice is the primary solution to the problem of keeping task difficulty within selected boundaries" (Fuller, 2005, p. 467).

The Theory of Planned Behaviour was a development of Icek Ajzen and Martin Fishbein's theory of reasoned action (Ajzen, 1991). In the Theory of Planned Behaviour it was proposed that actions that are under volitional control, actions that "the person can decide at will to perform or not perform the behavior" (Ajzen, 1991, p. 182), are preceded by an intention to carry out that behaviour. In the theory it was furthermore proposed that the intention is preceded by three

other internal concepts, attitude towards the behaviour, subjective norm, and perceived behavioural control. Without discussing this theory in detail, it relates to the question of whether or not speed is a conscious choice in that it held that intentions go before behaviour, and that attitude is one of the precursors for the intention. The theory has been often used as a basis to explain driver behaviours such as driving speeds (De Pelsmacker & Janssens, 2007); Iversen & Rundmo, 2012). In De Pelsmacker and Janssens study it was, for example, seen that moral values had a great influence on drivers speed choices. Thus, according to this study it was seen that what a driver thinks he or she ought to do affect their driving speeds.

If speed choice is the outcome of conscious and rational thinking and decision making, then the issue of individual rationality might help understand why drivers decide on different speeds. Elvik (2010) argued that rational thinking and evaluation is the basis for drivers' speed choices, however, he also added that drivers are not good at performing these evaluations. Earlier in this literature review individual irrationality was proposed to be one of the nine types of risk-factors (Elvik, 2004). With regards to speed choice, Elvik (2010) proposed that drivers lack the ability to choose speeds that are rational from an objective point of view (i.e. benefit the highest number of people on the road). Elvik proposed that cognitive limitations in drivers could account for the speeds we observe in the traffic. These limitations included: that drivers base their speeds on an overestimation of travel time savings, a disregard for other people in the road environment, on personal speed preference, and on an underestimation of both crash risk and severity. These types of cognitive limitations, which all involved drivers' poor probability assessment skills, were seen to account for why many

drivers travel faster than what is socially desirable. Elvik consequently argued a case for speed limits, saying: “Thus, the lack of objective rationality characterising driver speed choice would appear to be a strong argument for introducing speed limits” (2010, p. 202). However, this argument introduce another problem, which perhaps can be referred to as a ‘compliance problem’, namely that drivers do not necessarily comply with the speed limits.

1.6 Speed Control and the Compliance Problem

Controlling and reducing driving speeds has often been done by means of informing drivers of the speeds they ought to drive on given road sections. Speed limits have perhaps been most commonly used for this purpose. It has been said of speed limits that their function is to inform drivers of what speed they safely can select under average conditions (Goldenbeld & van Schagen, 2007). Speed limits (and speed limit enforcement) also have the function of keeping traffic speeds at somewhat the same level (Shinar, 2008). It has been said that the main point of developing safe speed limits and having drivers comply with them is traffic safety (van Nes, Brandenburg & Twisk, 2010). Establishing speed limits and finding ways of making drivers comply with them has indeed been a popular topic for many law makers and transportation agencies (Goldenbeld & van Schagen, 2007), as compliance with the speed limit reduce excessive speed as well as speed variability.

Rather than regulating drivers’ speeds through enforcement, an alternative approach to reducing driving speeds has been to inform and educate drivers about certain road risks. One direct approach of informing drivers of risk is to put up hazard warning signs which inform drivers of specific risks at specific locations

(Kanellaidis, Zervas & Karagioules, 2000). However, the need for accuracy and care when posting hazard warning signs has also been stressed in order that they remain effective (Kanellaidis et al. 2000). Another approach of informing drivers of risk has involved safety campaigns, where drivers are informed about the risks associated with driving at high speeds. Rundmo and Iversen (2004), for instance, developed a campaign specifically targeting speeding crashes. On the plus side, they found that it was relatively easy to change the way drivers thought about road risks. However, on the negative side, they also found that their safety campaign did not efficiently reduce drivers' actual risk taking (speeding) behaviour (Rundmo & Iversen, 2004).

It has been pointed out that: "setting a speed limit does not automatically result in the required speed behaviour" (Goldenbeld & van Schagen, 2007, p. 1121). This suggestion is supported by the fact that despite widespread implementation of speed limits, enforcement and safety campaigns, drivers on a daily basis break the speed limit and drive at excessive speeds. More specifically, the Organisation for Economic Co-operation and Development (OECD/ECMT) has reported that 50% of drivers commonly break the speed limit (2006). This number has also been confirmed in more recent times, where 50% of drivers report that they drive faster than the speed limit (Yannis, Louca, Vardaki & Kannelaidis, 2013). Those statistics in the face of the widespread presence of speed limits, enforcement, and education hints that perhaps the current speed regulation systems do not work as well as they should.

A potential problem with having speed regulation systems that are not functioning well is that they may contribute to an unsafe traffic system; both immediately and in the long run. An immediate way in which unrealistic or non-

credible speed limits threaten traffic safety is because of the riskiness associated with speed variability (Navon, 2003; Goldenbeld and van Schagen, 2007). There are also long term effects of non-credible speed limits on traffic safety; as suggested by Goldenbeld and van Schagen (2007): “eventually, if speed limits are regularly not in line with the characteristics of the road and the road environment, the speed limit system in general may be questioned by drivers” (p. 1121). In other words, the repeated exposure to unrealistic speed limits may make drivers lose their confidence in the appropriateness of speed limits, and ultimately lead drivers to drive at the speed they themselves think or feel is right. This potential danger has led researchers to look for alternative ways of regulating driving speeds. One way of increasing drivers’ compliance with the speed limit may be to make speed limits that are logical and appropriate from a drivers’ point of view, and that fits the characteristics of the road environment (Goldenbeld & van Schagen, 2007); a concept known as credible speed limits.

1.7 A Speed Limit Credibility Experiment

Credible speed limits are defined in terms of how drivers perceive them. A credible speed limit should meet most drivers’ expectations of the traffic environment that they are in (SWOV Institute for Road Safety Research, 2012), and it should also be logical and appropriate in view of the road characteristics (Goldenbeld & van Schagen, 2007). To give one example, drivers might consider a high speed limit to be credible on roads that are wide and straight (Goldenbeld & van Schagen, 2007), as the wide dimensions of the road might make you feel as though you are travelling slower (Näätänen & Summala, 1974). Another example of speed limits that are credible is what is known as dynamic speed limits, which

varies depending on the immediate environmental demands. A dynamic speed limit can for instance be when a speed limit drop to 40 km/h past a school and then returns to 50 km/h once the school area has been passed. Nes, Brandenburg & Twisk (2010) found that the participants in one experiment rated dynamic speed limits as being more credible than static speed limits. They also found that dynamic speed limits reduced speed variability, thus increasing traffic safety. Most of the participants in the experiment were also positive towards the introduction of dynamic speed limit systems, as they regarded the dynamic speed limits as useful (van Nes, et al. 2010).

Charles Goldenbeld and Ingrid van Schagen (2007) designed and carried out an experiment aimed at assessing the credibility of speed limits on 80 km/h rural roads in the Netherlands. In their experiment, 574 Dutch drivers viewed 27 digital photographs of rural roads and assessed them with regards to what speed they would like to drive at ('speed preference'), and what they considered to be a safe speed limit ('perceived safe speed limit'). The results reported from the experiment were that on average drivers preferred to drive 8 km/h faster than the speed limit of 80 km/h, and that drivers preferred to drive an average of 4 km/h faster than what they considered to be a safe speed limit (Goldenbeld & van Schagen, 2007). Hence, with regards to speed limit credibility, the results suggested that the 80 km/h speed limit was not entirely credible for the roads tested, but rather too low for the majority of the drivers.

The findings from the experiment uncovered two main challenges associated with determining the credibility of speed limits. Firstly, it revealed that there are challenges associated with how one operationalizes the term credibility. This was seen in that by the one measure of credibility (safe speed limit

perception) 84 km/h was regarded as a credible speed; whereas by the other measure of credibility (speed preference) 88 km/h was regarded a credible speed. It has consequently been pointed out that the way one operationalizes the term speed limit credibility has a large effect on what speed limit is deemed as credible (Goldenbeld, van Schagen, & Drupsteen, 2006). Secondly, as was revealed by the wide spread of answers in the speed limit credibility experiment, there are challenges associated with driver individuality. The standard deviations reported in Goldenbeld and van Schagen's experiment were large for both preferred speed and safe speed limit perception (though it was slightly larger for the preferred speed variable which measured the speeds drivers would like to drive in certain situations). Goldenbeld and van Schagen (2007) reported that individual differences with regards to speed preference were associated with age, sensation seeking, the number of speeding tickets, and where the participants lived. Finding the right speed limit from a driver's point of view may thus be challenging because of large differences between individual drivers (Goldenbeld & van Schagen, 2007).

Elvik (2010), was given access to the dataset from Goldenbeld and van Schagen's experiment and was particularly interested in the wide spread of answers in the data. By looking at the variable perceived safe speed limit he found that two main groups could be clearly identified Elvik (2010), and he referred to these two groups as 'fast movers' (those who considered 100 km/h to be a safe speed limit) and 'slow movers' (those who considered 80 km/h to be a safe speed limit). Finding a credible speed limit may, therefore, be particularly challenging if there are two main groups of drivers (the fast movers and the slow movers) on the road (Elvik, 2010).

With regards to speed preference, the results from the speed limit credibility experiment showed that overall drivers prefer speeds that are higher than the speed limits they perceive as safe (Goldenbeld & van Schagen, 2007). When commenting on this finding, Goldenbeld and van Schagen (2007) suggested that one reason why drivers preferred speeds that were higher than what they considered to be safe was that they had some sort of optimism bias. In other words, that a driver might think that he or she more safely can drive faster than other drivers. This idea has also been suggested by others, who have said that; “the tendency to believe oneself to be better than others prevails” (Rothengatter, 2002, p. 255). However, another possibility as to why drivers reported that they prefer higher speeds than what they consider to be safe, could be that they used the speed limit as a way to estimate the speeds they could drive at (Goldenbeld & van Schagen, 2007). For example, a driver might consider it safe to drive at 84 km/h in fine weather when they see that the speed limit is 80 km/h. Such an interpretation would be consistent with reports saying that a speed limit gives a driver certain expectations with regards to the road environment he or she is in (Stelling-Konczak, Aarts, Duivenvoorden & Goldenbeld, 2011).

1.8 A Survey on Driving Goals: Insight on Speed Preference

David Shinar (2008) conducted a roadside survey with 225 participants at various petrol stations in Israel, and was interested to find how drivers’ specific driving goals (usual speed, speed with family, economic speed, safe speed, fun speed, and legal speed) affected their speed choices. Three speed limits (80 km/h, 90 km/h and 100 km/h) were sampled in the survey, and all speed limits matched the design speed of the road (speeds that are safe from an engineering perspective). In

the analysis of this survey, the following two things were found. Firstly, it was found that roads that had been designed to produce lower speeds also corresponded to lower self-reported speeds. Secondly, it was found that different driver motives led to different speeds (Shinar, 2008).

Similar to the results in Goldenbeld and van Schagen's (2007) experiment, Shinar's study also found that drivers' prefer speeds that are higher than the speed limits they regard as safe. This was seen in that drivers reported to usually drive much faster than the posted speed limit and faster than the speed they regarded to be safe (Shinar, 2008). It was thus concluded that: "Finally, the actual speed drivers report driving on the road seems to be a compromise among the various motives, road design constraints, and enforcement, though it does seem – at least in Israeli driving culture – to be much more closer to the 'fun' speed than the 'safe' speed" (Oppenheim and Shinar, 2011, p. 199).

A survey with a similar focus was conducted by Yannis, Louca, Vardaki and Kanellaidis (2013). They analysed the results from a large survey conducted in 23 European countries where there were about one-thousand respondents from each country. They found that exceeding speed limits for the sake of pleasure only occurs to a significant degree on motorways, and reasoned that this was because those types of roads were most appropriate for higher speeds (Yannis et al. 2013).

1.9 Aims for This Study and Research Questions

In light of the above review of traffic crashes, speed, speed variability, risk perception theories, rational decision making theories, speed choice, speed limit credibility, driving goals and speed preference; it seems fitting to ask how, or which of these factors truly motivates and influence drivers' actual speeds, the

speeds that are observed in real traffic? It is hoped that by better understanding the processes that are involved in drivers' speed choices; one might better understand speed variability and thus positively contribute to the search for effective interventions to reduce speed variability in traffic. The main aim of this thesis is consequently to explore whether speed preference, the speed that drivers like to drive when motivated by different driving goals, correspond to the speeds that drivers actually drive on those same roads (speed choice). This thesis additionally seeks to explore whether there is a relationship between speed preference and risk perception. In order to explore these relationships, the following research questions will be addressed:

1. Can speed preference help explain actual driving speeds (speed choices)?
2. Are people's speed preferences associated with their levels of risk perception?

To answer these two questions this thesis used a combination of questionnaire and observational methods. Drivers were surveyed at various parking lots, and asked about their speed choice, ratings of safe speeds, preferred speeds and perceived risk. Observations with a speed gun were used to obtain actual driving speeds for the same roads.

2 Methodology

2.1 Participants

In total, 391 drivers were invited to participate in the questionnaire part of the study, and of these, 200 drivers consented to participate. Of the 200 participants who participated in the questionnaire, 7 were excluded entirely from the analysis. Two were excluded because their answers seemed to be greatly influenced by temporary road circumstances (one participant had driven through and was referring to a section of road works, and the other had been stuck in a traffic jam). The other five participants were excluded as they completed less than half of the questionnaire. The exclusion of these 7 participants left a total of 193 participants whose data was included in the analysis.

Of these 193 participants, 96 were male and 96 were female, with one participant who did not wish to disclose this information in the questionnaire. The participants' ages ranged from 17 to 85 years old, and the participants' mean age was 43 years ($SD = 15.6$). The majority ($n = 160$) of the participants held a full driving license, twenty-seven had their restricted license and three had their learner's license. Additionally, three participants in the questionnaire did not wish to declare what license type they held.

Fifty-three of the participants in this analysis were interviewed as they arrived for work at a large agricultural business at the outskirts of Hamilton. Likewise, 40 of the participants were interviewed as they arrived for work at a nearby business park. Fifty-two participants were interviewed as they were leaving work at one of Hamilton's large factories. Eleven of the participants were interviewed at a grocery store, and 37 of the participants were interviewed at one of the city's tourist attractions.

All the participants who were interviewed as they were either going to or leaving work (or the grocery store) were all very well acquainted with the roads, as most were used to driving these on an everyday basis. However, such a familiarity with the roads was not predominant among the 37 participants who were interviewed at the local tourist attraction. Many of the participants at the tourist attraction made it known to the researcher that they were visiting, either from other cities or from other countries.

The questionnaires and the data collection protocols were reviewed and approved by the School of Psychology Research and Ethics Committee.

2.2 Research Design

To answer the research questions at hand, data was collected in two ways; from a speed gun and from a questionnaire (see Appendix A). There were three primary measures of interest in this study, and these were: 1) speed choice, 2) speed preference and 3) risk perception. The first variable, *speed choice*, was defined as drivers' actual speed, and was measured in km/h at a particular moment and distance using the speed gun. This measure of speed choice will be referred to as 'observed speed'. A self-report measure of speed choice was also obtained by asking participants in the questionnaire to report their speed on the road they had travelled on, and this measure of speed choice will be referred to as 'speed rating'. Measures of the remaining two variables, *speed preference* and *risk perception*, were obtained from a series of questions in the questionnaire.

In this study, the variable speed preference was, in line with the Goldenbeld and van Schagen's (2007) speed limit credibility experiment, defined as the speed drivers like to drive at. However, adding more specificity to that,

speed preference was defined as the speed drivers like to drive when motivated by different driving goals. The idea of including ‘driving goals’ as an aspect of speed preference was adapted from Shinar’s (2008) survey. Quantitative measures of speed preference were obtained by asking drivers what speeds they would choose (in km/h) when they were motivated by various different reasons (Oppenheim & Shinar 2011). The questions will be described in more detail later. Risk perception was similarly measured by a series of questions in the questionnaire.

2.3 Apparatus and Materials

2.3.1 The Speed Gun

The speed gun used to record vehicle speeds in this study was a compact and hand held speed measurement laser. The speed gun (Stalker Lidar XS), which is depicted in Figure 1, was equipped with a battery handle with a trigger, a small screen, a ‘Head Up Display’ (HUD), audio feedback, and a choice of 6 different speed recording modes.



Figure 1. The speed gun (Stalker Lidar XS).

The speed gun measured vehicle speeds by means of a laser which sent out 130 pulses per second at a wavelength of 905 nanometres. From a distance of about 70 meters away from the traffic (which was the average distance for the speed measurements in this study), the speed gun's laser had a beam width of about 20 cm. The speed gun measured vehicle speeds by calculating changes in so-called time of flight. Time of flight was calculated by measuring the time it took for the laser to travel from the speed gun to the vehicle and then back again to the speed gun.

The 'single shot mode' was chosen for this study. This mode displayed a vehicle's speed momentarily, as it was recorded in a little less than a split second at a particular distance away from the speed gun. The vehicle's speed and distance were displayed on the speed gun's screen for an extended time after the trigger was pressed, allowing for sufficient time to copy this information to a specifically designed speed data collection sheet (Appendix B).

2.3.2 The Questionnaire

The questionnaire used in this study (see Appendix A) was administered verbally to the participants and took about 3 minutes to complete. The first section of the questionnaire collected demographic information including the participants' age, gender and license type. The second section of the questionnaire gained the participants' speed ratings. The questions in this section asked participants which road they came in on, as well as what their speed had been on that particular road. The third section of the questionnaire collected quantitative measures of speed preference using four questions. These questions were as follows: 1) What speed would you choose on [name of road] if your primary goal is to drive safely (safe

speed), 2) What speed would you choose on [name of road] if your primary goal is to save money on fuel (eco speed), 3) What speed would you choose on [name of road] to maximise the fun of driving (fun speed), and 4) What speed do you usually drive on [name of road] (usual speed)? A final question was also included in this section, which asked the participants: What is the legal speed limit on that section of [name of road]? These questions were, as mentioned, adapted from those developed by Shinar to compare speed choices when motivated by different driving goals (Oppenheim & Shinar, 2011). The fourth section of the questionnaire asked participants to assess the risk of the road that they had just been travelling on. The first question in this section was: On a scale of one to ten (one being 'not risky, ten being 'extremely risky') how risky would you rate [name of road]? This estimate of risk was used, because it was hoped to make it easy for the participants to give an 'on the spot', verbal evaluation of the general riskiness of the road. The next two questions asked the participants about the likelihood of crashes happening on that road; both in general and also to the drivers themselves: 1) What is the likelihood of a crash happening on [name of road], and 2) What is the likelihood of a crash happening to you on [name of road]? The purpose of asking for both the likelihood of a crash happening in general and also to the drivers themselves was to investigate the possibility of an optimism bias. This section ended with asking the participants whether they had ever been in a crash on that road. The crash history question was adapted from Pelz and Krupat's (1974) study on caution profiles and hazard detection among young male drivers. The fifth and final section of the questionnaire consisted of two questions asking participants about their history of speeding infringements. These two questions asked participants if in the past 12 months they had received

any speeding tickets on that road, and if so, how many. The speeding infringement question was included because of the finding in Goldenbeld and van Schagen's (2007) experiment, where individual differences in speed preferences were found to relate to the participants' speeding infringement history.

Participants were given a unique ID number. Each questionnaire also had room for a so-called vehicle recognition (VR) code, a code which was retrieved from a separate sheet of paper (a Vehicle Recognition Sheet, see Appendix C). The VR code was used when participants provided the first three letters or numbers of their car's licence plate. This was only obtained at certain locations where it was likely to observe the participants vehicles on the road with the speed gun. VR codes were used in order to match the on-road speed data with the corresponding questionnaire where possible.

2.3.3 The Roads

Speed data was collected with the speed gun on seven different through-roads or commute-roads with speed limits ranging from 60 km/h to 100 km/h. The roads, which are depicted in Figure 2, were: 1) Ruakura Road a (60 km/h), 2) State Highway (SH) 3 Ohaupo Road (70 km/h), 3) SH 26 Morrinsville Road (80 km/h), 4) Wairere Drive (80 km/h) 5) SH1 Cobham Drive (80 km/h), 6) Ruakura Road b (100 km/h), and 7) SH1 Great South Road (100 km/h).



Ruakura Road a – 60 km/h



Ohaupo Road – 70 km/h



Morrinsville Road – 80 km/h



Wairere Drive – 80 km/h



Cobham Drive – 80 km/h



Ruakura Road b – 100 km/h



Great South Road – 100 km/h

Figure 2. Speed data collection roads.

These roads were chosen because they were arterial roads with high speeds and few intersections. By choosing commute-roads with few intersections it was hoped that drivers' speed choices would be less influenced by impeding traffic, in other words that their speeds would be 'free'. These roads were also selected because of their nearness to places that were suitable for obtaining the questionnaires. Speed data was collected repeatedly on three of the roads (Ruakura Road – 100 km/h, Morrinsville Road – 80 km/h, and Cobham Drive – 80 km/h); but a particularly high number of repeated speed measures were obtained on Ruakura Road b (100km/h). The locations were chosen because they had good visibility and were at a safe distance from the traffic. Speed observation data was collected in good weather only.

2.3.4 Speed Data from the NZ Transport Agency (NZTA)

Speed data from the NZTA was available for five of the roads, and was used as an external comparison to the speeds that were observed in this study. The NZTA speeds had been collected over five weekdays (Monday to Friday) in March 2013 by a vehicle driving the distance during peak rush hour in the morning and in the afternoon, as well as during mid-day (Interpeak) (BECA Ltd, 2013). The average speed from the five days was calculated, and the averages were used as the external control in this study.

2.4 Procedure

2.4.1 Speed Gun Procedure

Speed data was collected in fine weather only at a close yet safe distance to the target-road, often from within a parked vehicle or, as displayed in Figure 3, from a nearby location (i.e. from a foot path).



Figure 3. Speed data collection.

Only vehicles that were travelling at the free speeds were measured. Free speed was defined as the vehicle ahead being no closer than 4 seconds and was measured by counting to four seconds (One-one-thousand... four-one-thousand). If no vehicle passed within four seconds then next vehicle would be taken as travelling at free speed and thus measured. The person collecting the speed data read (either silently or audibly) the first three digits of the vehicle's licence plate, and then immediately pressed the speed gun trigger. As soon as the speed gun had

successfully recorded the speed of the vehicle, then licence plate details would from memory be noted onto the speed data collection sheet (see Appendix B) along with the speed and range displayed on the speed gun. If the vehicle was still in sight, then the colour and type of vehicle (i.e. van, 2-door etc.) was also noted. This procedure of collecting vehicle characteristics was done in order to try to match vehicles on the road to participants in the questionnaire.

2.4.2 Questionnaire Procedure

The questionnaire was administered in five different parking lots, which were all near to the roads where the speed data was being collected during the same months. At two of the locations (the local tourist attraction and the grocery store) a poster was put up by the entrance to the parking lot to advise drivers that a questionnaire was being administered in the parking lot. At the other three locations (the two businesses and the factory), an email was either sent out to all the employees or to the managers, with a notification that a survey was being administered the next day.

At all five locations, a questionnaire stand was set up on the side of the parking lot. This stand was used to store some data collection materials, and also served the function of promoting the survey in order that some might be motivated to approach the questionnaire personnel. On a typical survey session, two people administered the questionnaire (this varied between 1 and 3 depending on availability). As seen in Figure 4, the questionnaire administrators wore fluorescent vests which were labelled “Driver Behaviour Questionnaire” in order that they were easily recognised as the official questionnaire representatives.



Figure 4. Person administering the questionnaire.

When people in the parking lot had parked and exited their cars, they were approached by a person administering the questionnaire with a brief verbal invitation to participate in a questionnaire. Those who said yes were then given more information about the questionnaire. This information, which was written on the first page of the questionnaire (see Appendix A), was presented verbally to the participant, and included the following details: Who was responsible for the questionnaire, the purpose for it, the duration of it (about 3 minutes), the assurance that all information would be kept in the strictest confidence, as well as the participant's right to withdraw at any time.

Due to the brief nature of the questionnaire and because participants' names were never to be known, informed consent was obtained verbally in the following way: If a participant consented to participate after hearing the information presented on the first page of the questionnaire, then he or she would

tick yes and place their initials on the questionnaire's front page, just below the information they consented to. After gaining informed consent, the questionnaire was verbally administered to the participant. When the questionnaire was completed, the participants were thanked for their time, and given the candy bar as well as an information pamphlet containing a short description of the purpose of the study and contact details (see Appendix D). The majority of participants completed the questionnaire in within the 3 minutes they were told that it would take.

2.5 Analysis

There were two main types of comparisons used in this study. In analyses where observed speed (obtained with the speed gun) was compared with measures in the questionnaire, comparisons were made on a 'per road' level. Analyses which only used data from the questionnaire made comparisons on an overall level (across all roads).

3 Results

The results will be presented in four main parts: speed choice, speed consistency, speed preference and risk perception. The first section, on drivers' speed choice, presents a comparison of observed speeds (collected with the speed gun) and speed ratings (obtained via the questionnaire) in order to examine the accuracy of the participants' self-reports. In this first section, the data from the NZTA will also be presented. The section on drivers' speed consistency looks at individual drivers' observed speeds across two or more days to provide some insight into the habitual side of drivers' speed choices, and provides further information on the accuracy and awareness of the participants' self-reports. In the third section, the participants' speed preferences (the speeds they would like to drive when motivated by different driving goals) are compared to their speed choices, in order to examine how driving goals affect drivers' selection of speed. In this section, it is also examined if perceived speed limit has any effect on the influence of speed preference on speed choice. Furthermore it is examined whether there is a relationship between the participants' speeding infringement history and their speed preferences. Finally, the fourth section examines the participants' ratings of risk and crash likelihood to determine if drivers' risk perception influenced drivers' speed choice and their speed preference. This section also compares the participants' crash history and their risk perception.

3.1 Drivers' Speed Choice per Location

Speed choice, in this study, refers to the actual speeds that drivers were travelling on the road, and was measured by a speed gun (observed speed) and by a questionnaire (speed rating). Both measures of speed choice were obtained from

the seven sampled locations: 1) Ruakura Road a (60 km/h), 2) Ohaupo Road (70 km/h), 3) Morrinsville Road (80 km/h), 4) Wairere Drive (80 km/h), 5) Cobham Drive (80 km/h) 6) Ruakura Road b (100 km/h), and Great South Road (100 km/h). Upon answering the speed rating question (what was your speed on X road?) 14.5 % of the total number of participants either did not know (6.7 %) or answered in terms of giving a range (7.8 %). Participants who did not know at what speed they had been travelling were excluded from this particular analysis, and for participants who gave their speed rating in terms of a range, the mid-point was used.

Figure 5 shows the results for each of the seven locations comparing the mean observed speed and the mean speed rating. Independent samples t-tests were conducted to see if the differences between observed speeds and the speed rating were significant. Significant differences between the observed speed and the speed rating were found at two of the locations, Morrinsville Road $t(63.268) = -6.576, p < .001$ and Great South Road $t(77) = -4.381, p < .001$. As can be seen in Figure 5 and in Table 1, the participants' mean speed ratings at these two locations were higher than the observed mean speeds. As indicated by the confidence intervals (CIs), the participants' speed rating also had greater variability. Although this trend was also seen at four other locations (Ruakura Road a, Ohaupo Road, Wairere Drive, and Ruakura Road b), the differences at these locations were not statistically significant. Cobham Drive showed the opposite trend, the speed rating at was lower than the observed speed.

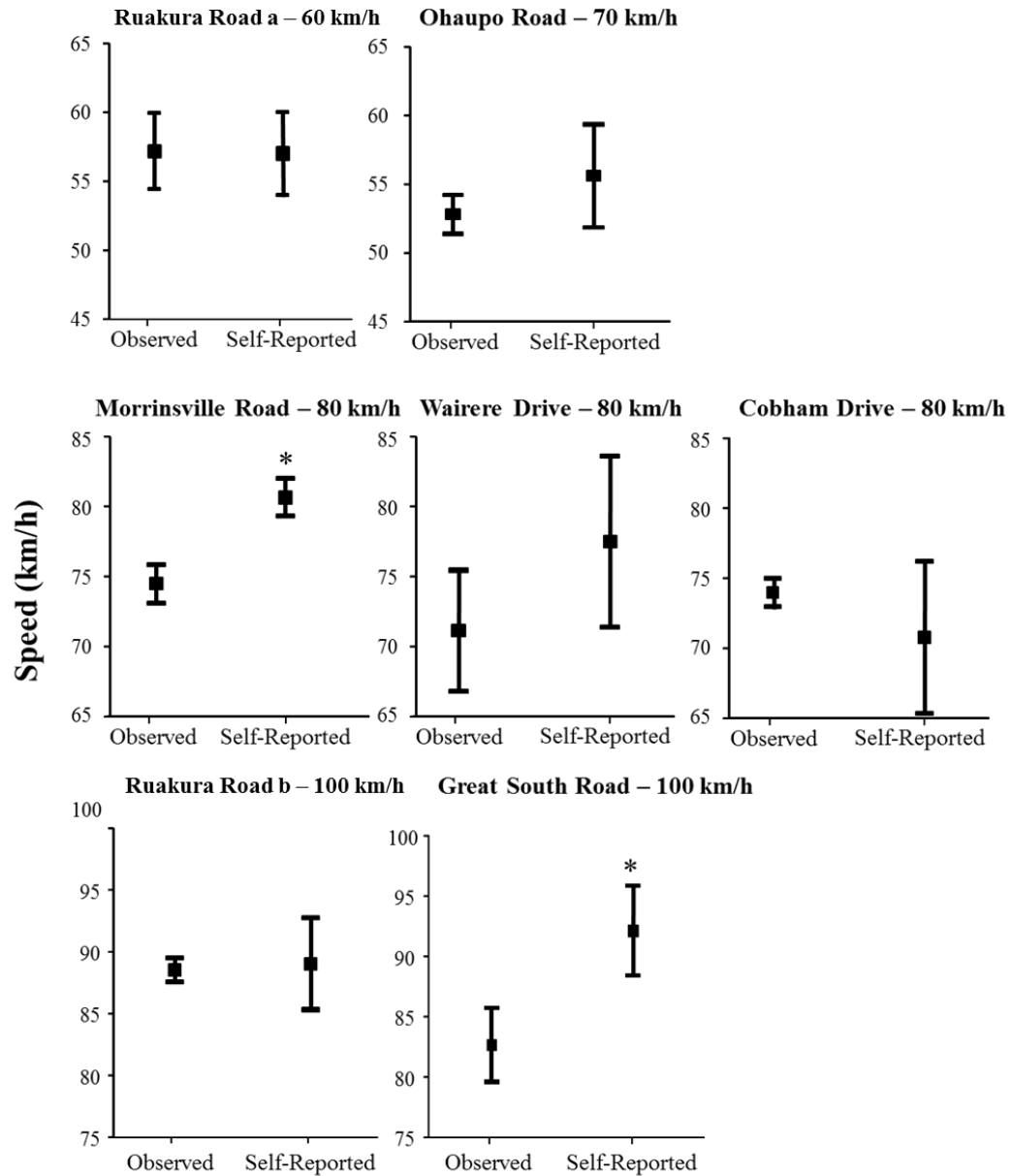


Figure 5. Mean speed choice per road. Lines show 95 % CIs, asterisk show differences significant p .001.

As seen in Table 1, for all the locations, mean observed speed was lower than the posted speed limit. Presented in Table 1 are the speed data from the NZTA, which shows the average speed for one vehicle at three times (morning rush = AM, mid-day or Interpeak = IP, and the afternoon rush = PM). The NZTA speeds were lower for most roads than the speeds observed and reported in this study, except for on Ohaupo Road and Great South Road. In Table 1, Ohaupo

Road is represented by two speed limits. The first, 70 km/h, refers to the speed limit at the site of the speed gun collection, whereas the second speed limit which is put in brackets (60 km/h) refers to the speed limit the participants in the questionnaire were referring to.

Table 1. Speed choice per location

Location	Speed Limit (km/h)	Observed Speed <i>M (SD)</i>	Speed Rating <i>M (SD)</i>	NZTA		
				Average Speed on Road Section for One Vehicle (km/h)		
				AM	IP	PM
Ruakura Road a	60	57 (7) <i>n</i> = 26	57 (7) <i>n</i> = 22	53	50	53
Ohaupo Road	70 (60)	53 (7.5) <i>n</i> = 112	56 (4) <i>n</i> = 8	59	56	62
Morrinsville Road	80	75 (8) <i>n</i> = 125	81 (3) <i>n</i> = 16	73	73	73
Wairere Drive	80	71 (11) <i>n</i> = 25	78 (10) <i>n</i> = 12	Not available		
Cobham Drive	80	74 (7) <i>n</i> = 183	71 (14) <i>n</i> = 28	38	63	56
Ruakura Road b	100	89 (8) <i>n</i> = 266	89 (10) <i>n</i> = 30	Not available		
Great South Road	100	83 (9) <i>n</i> = 32	94 (12) <i>n</i> = 47	85	86	86

3.2 Drivers' Speed Consistency at Two Locations

At two of the abovementioned locations, Morrinsville Road (80 km/h) and Ruakura Road b (100 km/h), observed vehicle speeds were measured repeatedly on several mornings. Since vehicle characteristics were also recorded, it was possible to compare their speeds across two different days, and in some cases, three different days.

The speeds of 46 vehicles were measured on two different days (not necessarily consecutive days), nine of these vehicles were observed on

Morrinsville Road and 37 of these were observed on Ruakura Road b. A paired samples t-test did not indicate any reliable difference between the speeds in km/h on Day 1 ($M = 87.06$, $SD\ 9$) and Day 2 ($M = 86.06$, $SD\ 10$). The results from these observations are displayed in Figure 6 (Morrinsville Road) and Figure 7 (Ruakura Road b). Figure 6 and Figure 7 show two data points per vehicle, representing the speed of that vehicle on Day 1 and on Day 2. The data points are categorised into groups according to how much the vehicle speeds differed from Day 1 to Day 2. As can be seen in Figure 6, five of the nine vehicles that were observed repeatedly on Morrinsville Road had less than 5% difference in their speed and only one vehicles' speed was more than 10% different across the two days.

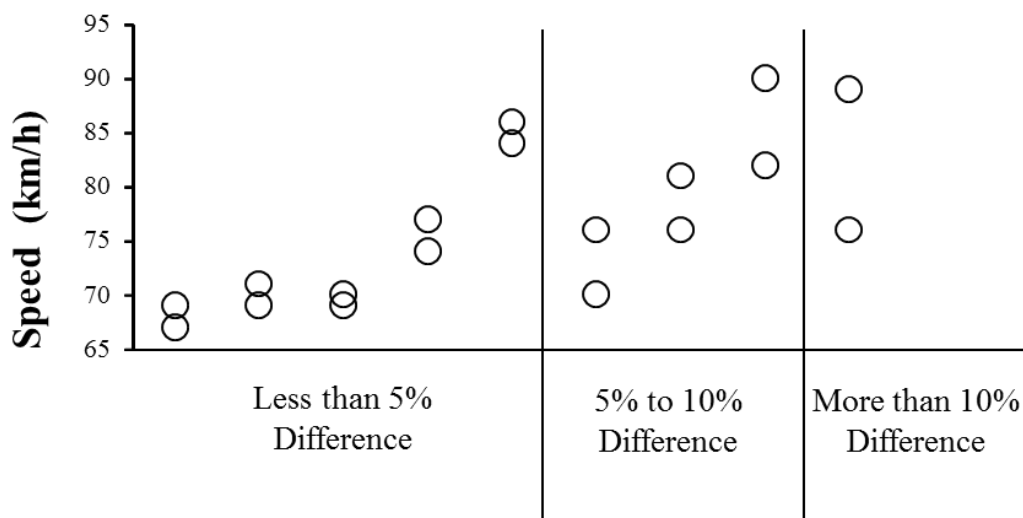


Figure 6. Speed consistency on Morrinsville Road (2 Days).

Vehicles on Ruakura Road b were less consistent in their speeds. As can be seen in Figure 7, fifteen of the vehicles that were observed repeatedly on Ruakura Road had less than 5% difference in their observed speed on Day 1 and Day 2, and 10 vehicles had speeds that were more than 10% different (12

vehicles' speeds differed between 5% and 10%). Nonetheless, speed consistency was fairly high; for the majority of vehicles ($n = 27$) the observed speed choice on Day 1 was less than 10% different to their speed choice on Day 2.

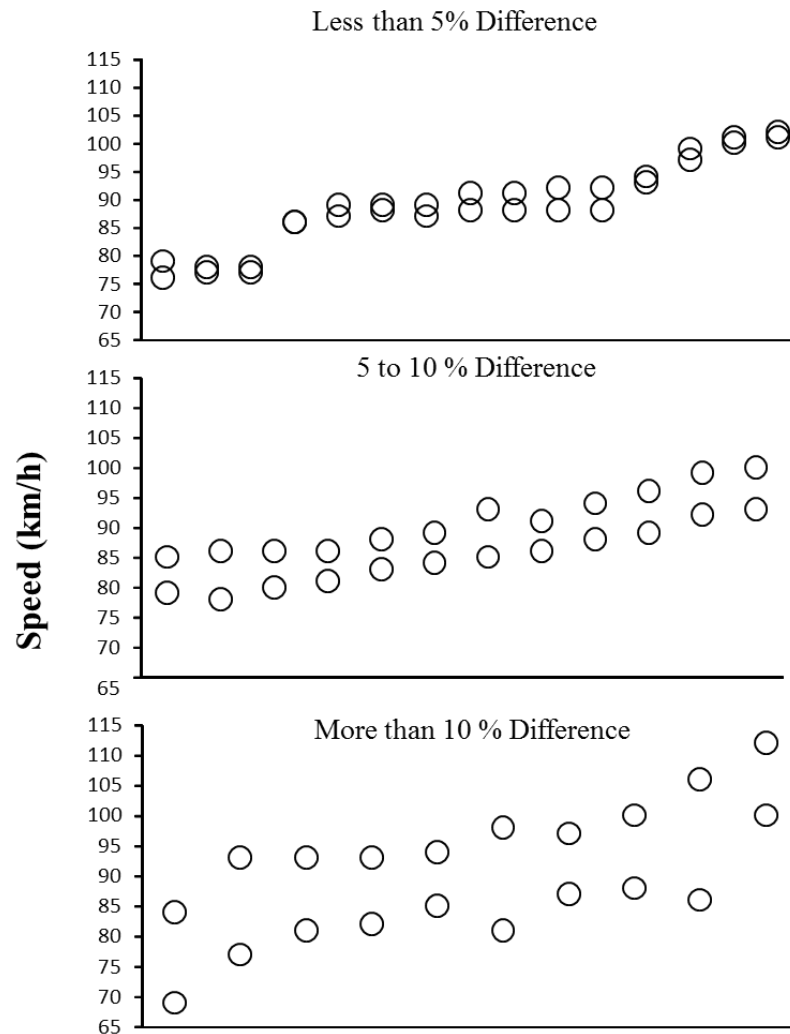


Figure 7. Speed consistency on Ruakura Road b (2 Days).

Two of the drivers whose speeds were measured across two different days on Ruakura Road b also completed the questionnaire. The first of these two drivers reported to usually drive this road at 90 km/h; 4 km/h (4.7 %) faster than their observed speed (86 km/h on both days). The second driver reported usually driving this road at 95 km/h; 1.5 km/h (1.6 %) faster than their observed speed

(Day 1 = 94 km/h, Day 2 = 93 km/h). What these two participants reported their usual speed to be was very similar to their observed speed.

Of the 46 vehicles described above, eight were measured on three different days, and one of these vehicles across five different days. Figure 8 shows the vehicles' speeds across three different days. In this figure, vehicles were arranged according to the road they were travelling on. The vehicle that was measured across five different days is shown at the far right of the graph. A one way analysis of variance (ANOVA), comparing the observed speeds across three days, did not indicate any reliable difference between the speeds on Day 1 ($M = 84.12$, $SD = 10$), Day 2 ($M = 84.87$, $SD = 11$), and Day 3 ($M = 83.25$, $SD = 6$).

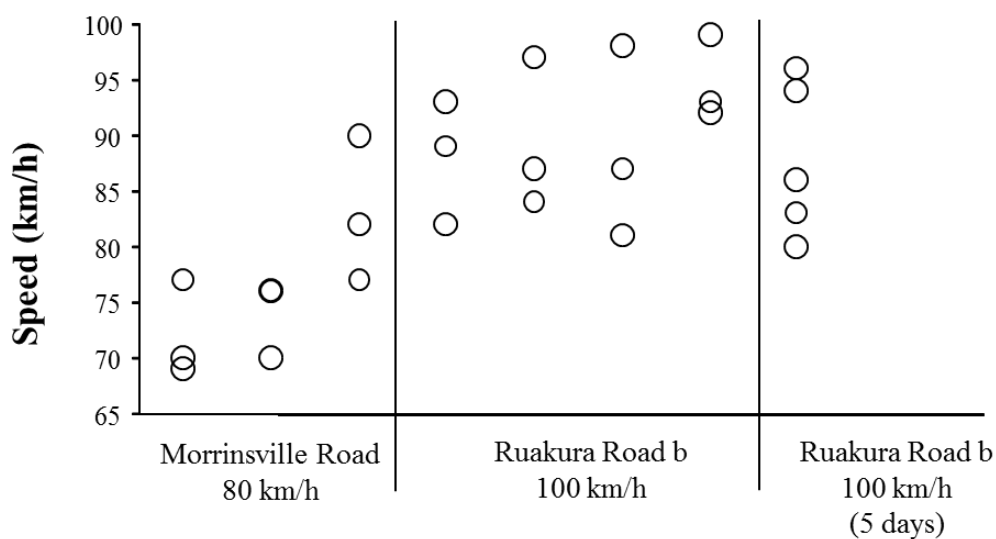


Figure 8. Speed consistency over three and five days.

3.3 Drivers' Speed Preference

Speed preference was defined as the speeds that drivers like to drive when motivated by different driving goals, and operationalised in terms of four questions in the questionnaire: What speed would you choose on [name of road]

1) if your primary goal is to drive safely (safe speed), 2) if your primary goal is to save money on fuel (eco speed), 3) to maximise the fun of driving (fun speed), and 4) what speed do you usually drive on [name of road] (usual speed)? Five analyses are presented below. The first analysis explored if there were significant differences between the speed preference measures at each of the seven locations. The second analysis examined the relationship between the four speed preference measures. The third analysis compared speed preference to the participants' speed ratings and their observed speeds, to see if perhaps speed preference could help explain their speed choices. The fourth analysis explored whether there was a relationship between risk perception and speed preference. The fifth analysis investigated the relationship between participants' speeding infringement history and their speed preferences.

3.3.1 Differences in Speed Preference per Location

As can be seen in Figure 9, the speed preference results at each location showed similar trends, with fun speed yielding the highest speeds, followed by usual speed, then safe speed, and eco speed the lowest. Fun speed also showed the greatest variability as reflected in the large CIs in Figure 9. One-way repeated measures ANOVAs with post-hoc pairwise comparisons (Least Significant Difference) were conducted to see if there were reliable differences between the speed preferences at each location. Statistically significant differences between the speed preferences were found at the following three locations: Ruakura Road a (60 km/h), Wilks' Lambda = .59, $F(3, 16) = 3.68$, $p = .035$; Cobham Drive, Wilks' Lambda = .67, $F(3, 24) = 3.86$, $p = .022$; and Ruakura Road b (100 km/h), Wilks' Lambda = .45, $F(3, 29) = 12.08$, $p < .001$. The post-hoc tests showed that

on Ruakura Road a, fun speed was significantly higher than all the other speed preference measures ($p < .05$), and also that usual speed was significantly higher than eco speed ($p < .05$). On Cobham Drive, all but two speed preference measures (usual speed and safe speed) were significantly different to each other. On Ruakura Road b (100 km/h) fun speed was significantly higher than the other speed preference measures.

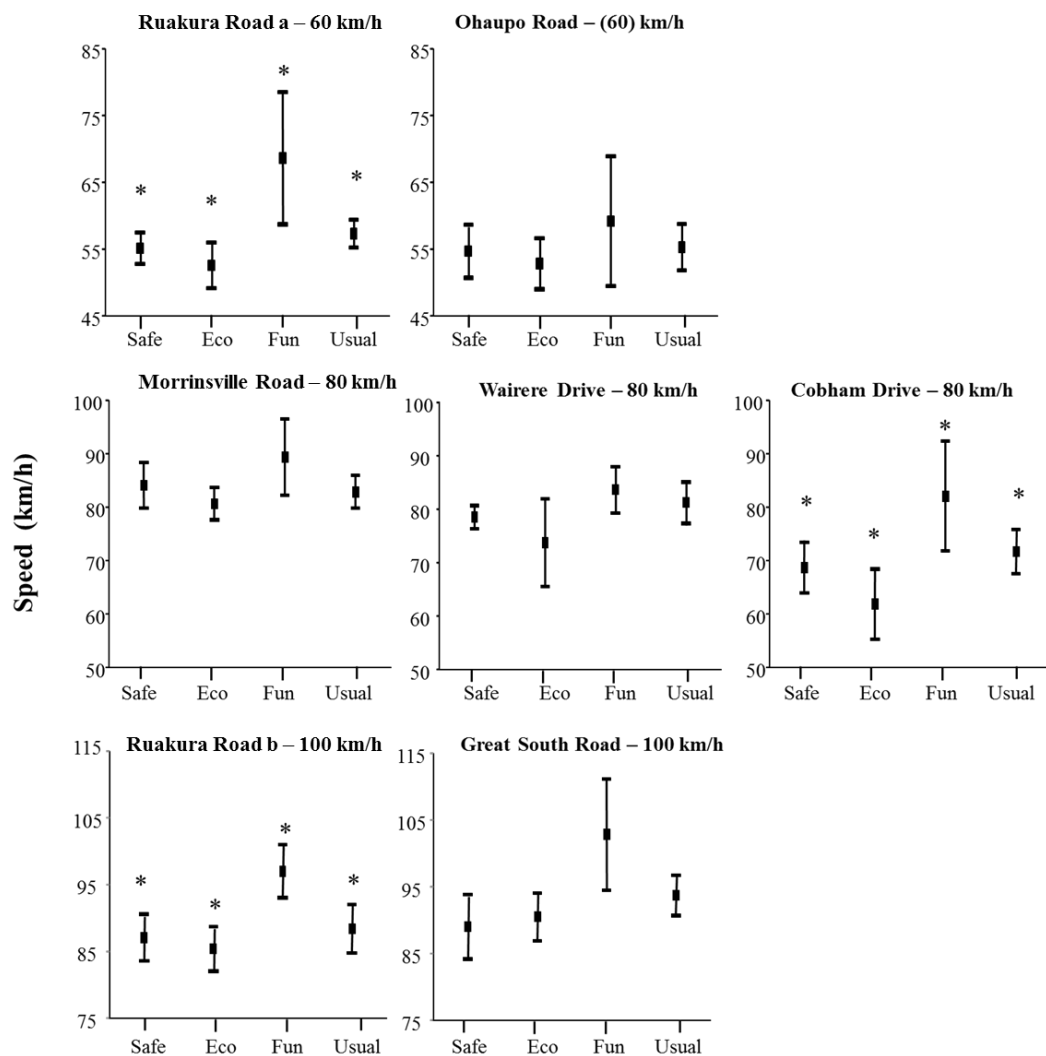


Figure 9. Mean speed preference per road. Lines show 95 % CIs, asterisks show significant differences $p < .05$.

3.3.2 Correlations among the Speed Preference Measures

For the remainder of the analyses on speed preference, data from all (193) participants who completed the questionnaire were included. For the purpose of these analyses, one outlier was excluded whose response to fun speed was 280 km/h. Analyses (Pearson's r) revealed that the four speed preferences were significantly correlated. The highest correlation was observed between usual speed and safe speed, where there was a strong positive correlation, $r = .84$, $n = 185$, $p < .001$. Usual speed was also found to correlate strongly with eco speed ($r = .84$, $n = 175$, $p < .001$). The smallest correlation was observed between fun speed and eco speed, $r = .5$, $n = 163$, $p < .001$; and fun speed was also found to correlate the least (though still rather highly) to the two other speed preference measures; safe speed ($r = .6$, $n = 173$, $p < .001$) and usual speed ($r = .68$, $n = 172$, $p < .001$).

3.3.3 Drivers' Speed Preferences and Their Speed Choices

3.3.3.1 Speed Preference and Speed Ratings

Table 2 presents the means and standard deviations for the participants' speed preferences, speed rating, and their speed limit belief. As can be seen in Table 2, the speed preference measure which corresponded most closely with the participants' speed rating was usual speed. As can also be seen in Table 2, two of the average speed preference measures (eco speed and safe speed) were rated as lower than the average speed rating, and the other two speed preference measures (fun speed and usual speed) were rated as higher. The only speed preference measure to exceed the participants' speed limit belief was fun speed.

Table 2. Participants' speed preference, speed rating and speed limit belief in km/h. Means, standard deviations and sample sizes are included.

Measure	M (km/h)	SD (km/h)	n
Safe speed	77.51	17.82	188
Eco speed	75.24	18.95	177
Fun speed	88.30	24.59	174
Usual speed	80.04	16.94	190
Speed rating	79.50	18.06	183
Speed Limit Belief	81.87	16.51	190

To determine if speed preference could help explain drivers' speed choices, partial correlations were used to explore the relationship between the participants' speed preference and their speed ratings. The independent variables were the four speed preference measures, and the dependent variable was speed rating. As can be seen in Table 3, after controlling for the effects of the three other speed preferences, usual speed was found to explain 46% of the variance in the speed ratings, $r = .46$, $n = 153$ $p < .001$. The second highest percentage of variance explained was for fun speed (35%), followed by safe speed (27%) and eco speed (22%).

Participants' speed limit belief (what they thought the speed limit was for the road) also showed a large positive correlation to their speed rating ($r = .864$, $n = 180$, $p < .001$). Because of this relationship it was of interest to explore whether speed limit belief influenced the speed preference variables. Consequently, partial correlations were again used to explore the relationship between the four speed preferences and the participants' speed limit belief (independent variables) and the participants speed ratings (dependent variable). As can be seen in Table 3, after controlling for the influence of these variables both usual speed (34%) and fun speed (34%) were found to explain the greatest amount of variance observed in the speed rating. Thus even with the inclusion of speed limit belief, eco speed

(18%) and safe speed (23%) still displayed the smallest partial correlation to the speed rating. The speed preference measure which was most highly affected by the participants' speed limit belief was usual speed, whereas the speed preference measure that was the least affected by speed limit belief was fun speed.

Table 3. Speed preference and speed rating
Partial Correlations (r.)

	Without Speed Limit Belief ($n = 153$)	With Speed Limit Belief ($n = 150$)
Safe Speed	.27**	.23*
Eco Speed	.22**	.18*
Fun Speed	.35**	.34**
Usual Speed	.46**	.34**

* $p < .01$ ** $p < .001$

It may be worth noting that fun speed and eco speed were the two measures of speed preference that received the largest number of comments from the participants. Before giving an estimate of fun speed and eco speed, many participants would express that they found it difficult to answer in terms of giving a speed or speed range. Often they would rather define fun speed and eco speed in other terms than km/h. For eco speed, for example, one comment was "I'd use a horse", and for fun speed comments were very varied, such as: "as fast as the car can go", and "fun is not about the speed you are driving, but about the music you are playing".

3.3.3.2 Speed Preference and Observed Speeds

For nine of the participants who completed the questionnaire, observed speed was also obtained. This made it possible to compare their speed preference measures to their actual on road speeds. Seven of these participants came from Ruakura

Road b (100km/h) and two came from Morrinsville Road (80km/h). Analyses (Pearson's r) were conducted comparing the speed preferences, speed rating and observed speed for these 9 participants. While there were no significant correlations between the participants' observed speed and any of the four speed preference measures (or between their observed speed and their speed rating), the highest correlation was found between observed speed and fun speed ($r = .4, p = .296$).

As for the correlations among the speed preference measures, the results for these nine participants were similar to the results for all the participants, that usual speed was most highly correlated to usual speed ($r = .9, p < .001$). There were also some differences in how the two roads were rated in terms of speed preference. On Ruakura Road b, the speed preference measure that was most similar to the participants' observed speed (89.1 km/h) was safe speed (88.6 km/h) followed by usual speed (92.3 km/h). This was different to Morrinsville Road, where eco speed (80 km/h) and usual speed (80 km/h) were most similar to the participants' mean observed speed (83 km/h). On Morrinsville Road, safe speed (90 km/h) was rated as much higher than the mean observed speed (83 km/h).

3.3.4 Risk Perception and Speed Preferences

To explore whether there was any relationship between the participants' ratings of risk on any of the speed preference measures, tests for correlation (Pearson's r .) were conducted. There were no significant correlations between any of the risk perception measures and any of the speed preference measures.

3.3.5 Drivers' Speed Preference and Their Speeding Infringement History

A comparison was made to see if there was a difference with regards to speed preference between the six participants who reported to have received a speeding ticket on the target road in the last 12 months and the 184 participants who reported to not have received a ticket. As can be seen in Figure 10, four of the six participants who had received a speeding ticket gave higher speed preference ratings than the median speed preference measures for those who had not received a ticket.

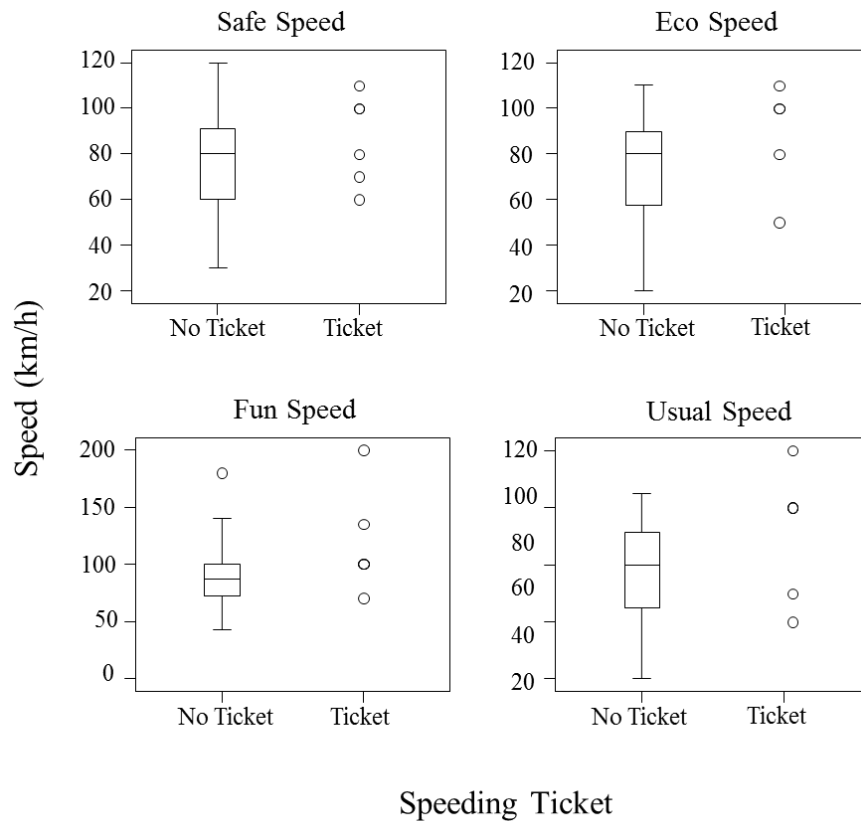


Figure 10. Speed preference and speeding infringement history.

3.4 Drivers' Risk Perception

Risk perception was operationalised by means of three questions in the questionnaire: 1) on a scale of one to ten (one being not risky, ten being extremely risky), how risky would you rate [name of road] (riskiness), 2) what is the likelihood of a crash happening on [name of road] (general crash likelihood), and 3) what is the likelihood of a crash happening to you on [name of road] (personal crash likelihood)? The first analysis compared the responses to the three risk perception questions at each location. The second analysis examined the relationship (using correlations) between the three risk perception measures. The third analysis compared the three risk perception measures to the participants' speed rating. The last analysis focused on differences in risk perception ratings between the participants with –and without a crash history on the target road.

3.4.1 Risk Perception per Location

As can be seen in Figure 11, all roads except for one (Wairere Drive) were rated as being 'on' or 'just under the middle' of the 10 point scale. Wairere Drive however, was rated as less risky than the other roads ($M = 3.21$, $SD\ 1.72$). The highest risk rating was given at Cobham Drive ($M = 5.33$, $SD\ 1.64$). A one-way between-groups ANOVA revealed that in terms of ratings of riskiness there were no significant differences between locations. When asked to give their riskiness rating many participants commented that riskiness of the road depended on temporary things, such as the traffic volume, the curvature of the road and the number and difficulty of intersections. If they struggled to give a numerical measure of riskiness, they were instructed to base their answer on the conditions

in which they had just driven, and not to think particularly of the intersections, but rather the open road.

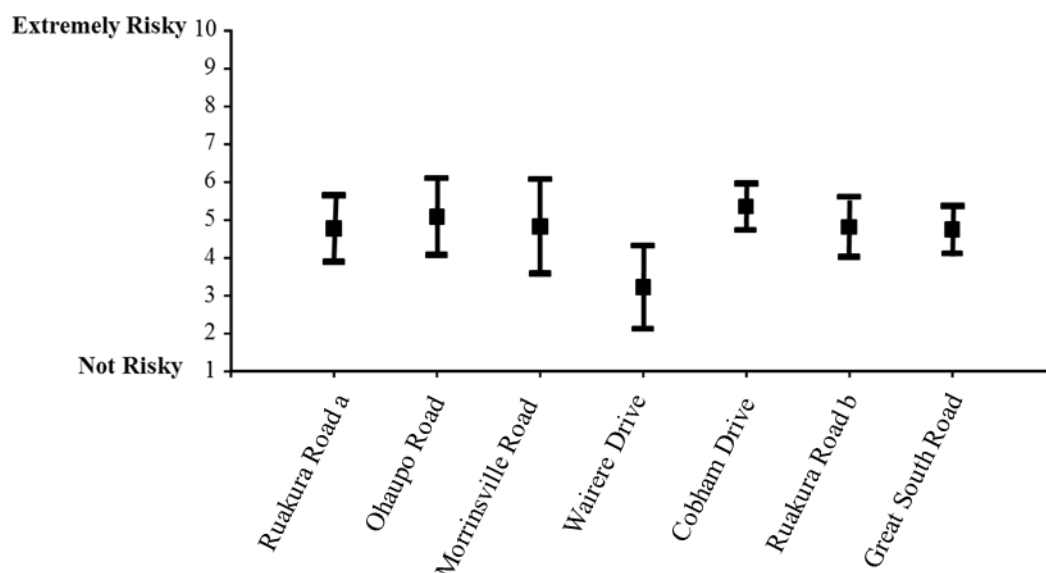


Figure 11. Riskiness rating per road. Lines show 95 % CIs.

As can be seen in Figure 12, the probability of being in crash did not appear to be related to the speed limit. The left panel in Figure 12 shows the participants' overall rating of general crash likelihood, and the right panel shows the participants mean rating of personal crash likelihood. A quick glance at both panels show that there was a tendency to estimate that a crash happening in general was more likely than a crash happening to the participants themselves. At all but one location, Wairere Drive, general crash likelihood was on average rated to be somewhere between 'likely' and 'neither likely nor unlikely'. On Wairere Drive, the chance of a crash happening was rated closer to 'unlikely' than to 'neither likely nor unlikely'. At all locations, personal crash likelihood was on average rated as close to 'unlikely'. Statistical tests (one-way between-groups

ANOVAs) across the different locations revealed that there were no significant differences for crash likelihood (both general and personal).

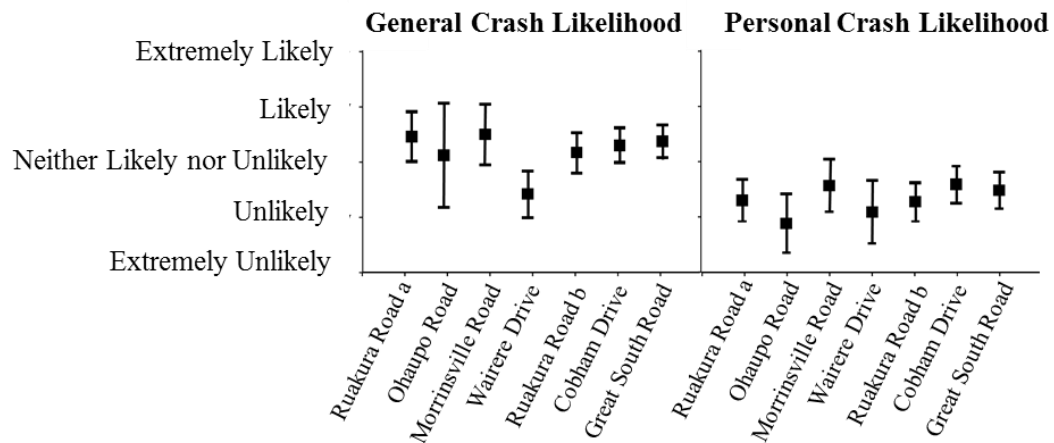


Figure 12. Crash likelihood rating per road, lines show 95 % CIs.

3.4.2 Correlation between the Risk Perception Measures

For the remainder of the analyses on risk perception, data from all 193 participants were included in the analysis (these were not included in the analyses which compared risk perception per location). Correlation between riskiness, general –and personal crash likelihood showed that there was a positive correlation between the general – and personal crash likelihood ratings ($r = .487$, $n = 190$, $p < .001$). In other words, as the general likelihood of a crash increased, personal crash likelihood also increased. The correlations between overall perceived riskiness and the two crash likelihood ratings were not statistically significant.

A test for correlation (Pearson's r) was used to explore whether there was a relationship between drivers' risk perception and their speed choice. There were

no significant correlations between any of the risk perception measures on the participants speed rating.

A comparison was made to see if there was a difference with regards to risk perception between the 8 participants who had crashed on the target road and the 185 participants who had not. As can be seen in Figure 13, the majority of the participants who had experienced a crash on the road rated it as more risky than the median riskiness reported by the other participants.

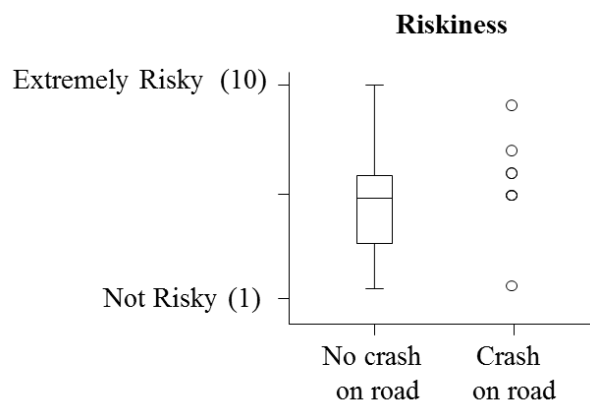


Figure 13. Participants' crash history and their riskiness rating.

As can be seen in Figure 14, personal crash likelihood ratings were similar between both groups of participants (those with a crash history on the road, and those with no crash history). With regards to general crash likelihood, however, there appeared to be a slight difference. The participants who had experienced a crash on the road rated the likelihood of a crash happening in general as more likely than the participants who had not experience a crash on the road

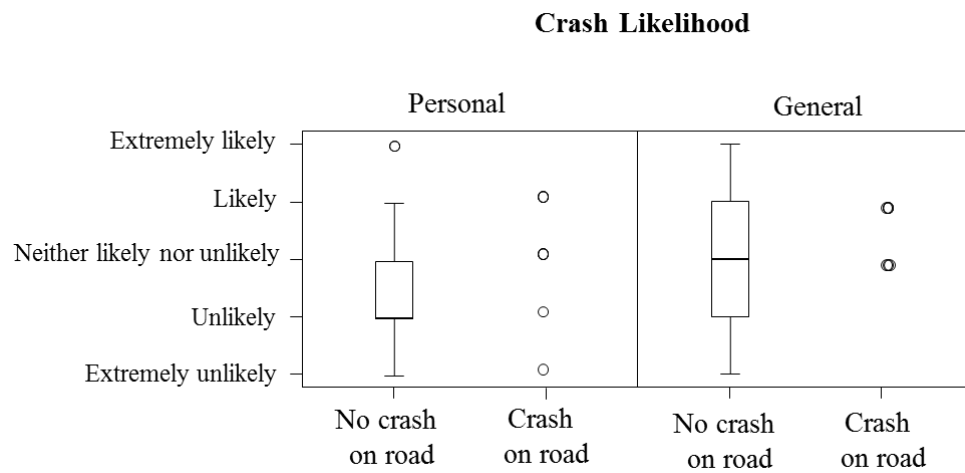


Figure 14. Participants' crash history and their crash likelihood ratings.

4 Discussion

4.1 Research Findings

In response to the first research question: Can speed preference help explain speed choice? The results in this study indicated that the answer is yes. Speed preference was seen to influence the participants' speed ratings, and also corresponded to their observed speeds. The findings in this study therefore suggest that speed preference help explain some of the speed variability observed on roads today since different drivers may be motivated by different goals, and also since drivers like to drive at different speeds.

As for the second research question: Are people's speed preferences associated with their levels of risk perception? The results in this study did not find any evidence of such a relationship, which suggest that drivers' risk perception (as defined in this study) determines neither their speed choices nor the speeds they prefer to drive at (speed preference).

4.1.1 The Influence of Speed Preference on Speed Choice

Returning to the first research question, that speed preference help explain drivers' speed choices was perhaps seen most clearly in the partial correlations between the participants' speed preferences and their speed ratings. All four speed preference measures were seen to explain some of the variance in the participants' speed ratings. Of the four speed preference measures, usual speed was most similar to the participants' speed ratings and was also found to explain most (46 %) of the variance (followed by fun speed, 35%; safe speed, 27%; and lastly eco speed, 22%). First of all, the partial correlations suggested that speed preference is linked to speed choice (measured as speed rating). Secondly, that usual speed was

seen to explain the most of the variance in the participants' speed ratings would furthermore suggest that drivers drive at the speeds that they do, in a large part, because they are used to it. Because usual speed was the most influential component in the speed preference term, one could suggest that speed preference involves a consistent liking for certain speeds over others, rather than mere momentary motives. The idea of consistency in speed preference was further supported by the finding in this study that drivers were consistent in their choice of speed (as was seen in the driving speeds for those who were measured repeatedly on Morrinsville Road and Ruakura Road b), a finding which has also been made in previous research (Haglund & Åberg, 2002).

Together, these two findings on usual and consistent speed may lend support to theories which suggest that habit plays a role in drivers' speed choices. It would, for instance, relate to one model for speeding behaviour put forward by De Pelsmacker and Janssens (2007). Their theory, which was based on the Theory of Planned Behaviour (Ajzen, 1991) held that habit influence speed behaviour to a strong degree and in a direct way (De Pelsmacker & Janssens, 2007). The findings on usual and consistent speed would also support the Tandem Model proposed by Charlton & Starkey (2011, 2013), which has suggested that driver behaviour is maintained by two processing states, an operating process and a monitoring process, and that the latter of these two processing states happen without the driver's awareness. In their experiment using a driving simulator it was found that as participants became familiar with roads they became less aware of the driving task (Charlton & Starkey, 2013). Similarly, the large majority of the surveyed participants in the current study were familiar with the roads that they had been

travelling on, and in view of the Tandem Model one could perhaps say that their speed choice was happening somewhat automatically.

The possible influence of habit on speed choice relates to the general question which was raised in the above literature review: is speed the result of a conscious rational choice? These results (which hint that driving speeds are often influenced by habit) would seem to support the notion that speeding can occur without much cognition or conscious awareness. Yet, as was suggested in the Tandem Model, a state of unawareness may be terminated by a conscious choice (Charlton & Starkey, 2011). Similarly, in this study, when participants were asked what speed they had been travelling at most (85%) were able to give an answer. The high percentage of participants who knew what speed they had been travelling at would suggest that they at some point during their drive had been aware of their speed. For example, one participant when asked what speed he had been traveling at confidently replied: “104 km/h”, and referred to the point in time when he set the adaptive cruise control.

To sum up this section, these results would first of all suggest that there is a link between speed preference and speed choice; and secondly hypothesise that that the way in which speed preference often influence speed choice is by the way of habit.

4.1.2 The Effect of Speed Limit Belief

The results in this study would suggest that what the participants believed the speed limit to be (speed limit belief) affected the strength of the relationship between speed preference and speed choice (measured as speed ratings). Usual speed, for example, was most greatly influenced by the participants’ speed limit

belief. This was seen in that after controlling for the influence of speed limit belief, usual speed explained 34% of the variance in the speed ratings (12% less than before). Fun speed, however, was much less associated with speed limit belief. After controlling for the effect of speed limit belief, fun speed was found to explain 34% of the variance in the speed ratings, nearly as much as before (1% less). Similarly, both safe speed and eco speed explained 4% less of the variance in the speed ratings after controlling for the influence of speed limit belief.

That speed limit belief affected the relationship between speed preference and speed choice in varying degrees, may be of particular relevance to the issue of speed limit compliance. Could it be that speed preferences with a high resilience to the influence of speed limit belief help explain why speed limits are broken? In this study only a low number of participants had received a speeding ticket on the road in the past 12 months, which made a statistical comparison unsuitable. However, it was observed that the participants who had received a speeding ticket rated many of the speed preference measures higher than the participants who had not; which could suggest that speed preference may potentially explain part of their lack of compliance. This finding was similar to the result in Goldenbeld and van Schagen's (2007) experiment, where differences in speed preference were related to participants' speeding infringement history. Shinar (2008) similarly suggested that when drivers prefer much higher speeds than the posted speed limit it may result in a lack of compliance.

4.1.3 Different Driver Motives Lead to Speed Variability

In this study the four different speed preference measures (or motives) were associated with different speed choices. For example, at all the sampled locations

fun speed was rated as higher than the other speed preference measures, and similarly safe speed, eco speed and usual speed were all rated differently to each other. This trend would suggest that driving speeds vary depending on what the motive of the drive is.

That different motives lead to different speed choices was similar to a suggestion made in the Theory of Planned Behaviour, where intentions were seen to influence behaviour (Ajzen, 1991). However, it should be noted that the terminology used in the Theory of Planned Behaviour and that used here is somewhat different, as ‘intentions’ suggest cognition and awareness, whereas ‘motives’ can merely refer to an unconscious inward prompting which affects a person’s behaviour (Oxford University Press, 2013; motive, n). While ‘motives’ and ‘intentions’ may be somewhat different terminology, both the Theory of Planned Behaviour and these results would suggest that motivational factors influence driving behaviour. In that regard, these results were very alike those reported by Shinar (2008), where it was found that “different driver motives lead to different speed choices” (p.280).

In light of the findings from both Shinar’s (2008) study and this study, one way in which speed preference can be seen to produce speed variability is in that drivers have different motives. Yet the relationship between different motives and speed variability may perhaps be influenced by the credibility of the speed limits, as was indicated by one of the differences between the results in this study and those in Shinar’s (2008) study. In Shinar’s study (which used similar measures), average safe speed, eco speed, fun speed and usual speed were all rated above the speed limit. However, in this study most of the speed preference measures (safe speed, eco speed and usual speed) were on average rated as lower than the speed

limit. Shinar (2008) commented that the speed limits in his survey matched the design speed (the speeds in which a car from an engineering perspective can drive safely). The roads in this study, however, were selected on the basis that they were high speed routes and near to suitable survey locations, rather than considering the design speed. It would therefore be likely that the roads in this study had varying degrees of speed limit credibility. For example, at one location (Morrinsville Road), where all the speed preference measures were rated higher than the speed limit, one could perhaps suggest that the speed limit was not entirely credible, but rather too low for the majority of drivers. In contrast on Ohaupo Road, where all the speed preference measures were rated under the speed limit, it could potentially be that the speed limit was regarded as too high for the majority of drivers. At many of the other sampled locations, the results with regard to speed limit credibility were less clear; as eco speed, safe speed and usual speed were often rated under the speed limit whereas fun speed was rated as higher than the speed limit.

On the topic of different driver motives (or the differences between the speed preference measures), at three locations (Ruakura Road a, Cobham Drive, and Ruakura Road b) there were significant differences between the speed preference measures. One might ask why there were significant differences between the speed preference measures at these three locations and not at the others. One explanation could be that at these three locations the road environments were ambiguous or confusing, and that they made it difficult for drivers to interpret and determine the credibility of the speed limits. Such an explanation would suggest that, at these three locations, changes in the road environment would be needed in order to make the design speeds (or safe speeds)

more clearly understood by drivers. The possible relationship between ‘speed preference differences’ and ‘road environment ambiguity’ was also pointed out by Shinar (2008), who said that perceived design speed may often be different to actual design speed, which is problematic. He pointed out that the problem occurs when drivers fail to perceive risks that are in fact present; a point which has similarly been made by Elvik (2010) who suggested that drivers select high speeds because they do not think that they are at risk when they in fact are.

To sum up this section, the results in this study suggested that different speed preferences (driver motives) lead to different speeds, and that speed preference may thus also help explain the problem of speed variability. However, in light of the differences between the results in this study and those reported by Shinar (2008), it may be possible that the credibility of a speed limit affects the extent to which different motives lead to different speeds.

4.1.4 Why Drive Faster than What Is Safe?

In Goldenbeld and van Schagen’s (2007) experiment, it was found that drivers preferred to drive 4-5 km/h faster than the speed limit they perceived to be safe (Goldenbeld & van Schagen, 2007). When commenting on their finding, that drivers liked to drive faster than what they considered to be a safe speed limit; Goldenbeld and van Schagen (2007) hypothesised that the difference might be due to an optimism bias or alternatively due to drivers using the speed limit as a general guide which they may exceed in fine weather and easy road conditions.

It is likely that the ‘perceived safe speed limit’ measure used in Goldenbeld and van Schagen’s (2007) experiment resembled the ‘safe speed’ measure used in this study. With that in mind, a similar observation was made in

this study: The average speed rating given by the participants in this study was higher ($M = 79.50$ km/h, $SD = 18.06$ km/h, $n = 183$) than the reported a safe speed ($M = 77.51$ km/h, $SD = 17.82$ km/h, $n = 188$). Similar to the results in Goldenbeld and van Schagen's (2007) experiment, drivers in this study thus drove approximately 2 km/h faster than what they thought to be safe. This was also similar to Shinar's (2008) finding, where participants rated their usual speed as higher than their safe speed.

Like the road scenes used in Goldenbeld and van Schagen's experiment, the roads in this study were only sampled in fine weather conditions, which would give support to their second suggestion; that drivers felt that the dry road conditions and clear visibility allowed for higher speeds on that particular day. However, it should be re-emphasized that Goldenbeld and van Schagen (2007) found that weather conditions could explain why drivers exceeded the (safe) speed limit, as drivers were thought to use the speed limit as a general guide to speed selection. However, in this study drivers reported that they had been driving faster (and that they usually drove faster) than what they regarded to be a safe speed. How can one account for the finding that drivers travelled faster than what they considered to be safe? When commenting on a similar finding, Shinar (2008) suggested that driving speeds were the result of compromising many different driver motives. In light of such an interpretation, one could suggest that other motives led drivers to drive faster than what they perceived to be safe. Though, as was seen by the high correlation between usual speed and safe speed in this study ($r = .84$), what the participants reported to be a safe speed did seem to have a strong positive relationship with what speed they usually drove at.

With regards to the possibility of an optimism bias (Goldenbeld & van Schagen, 2007; Rothengatter, 2002), participants in this study tended to rate it more likely for a crash to happen in general than the likelihood of a crash happening to them, and so in this study also there did seem to be support for some sort of optimism bias. Yet, it was interesting that those who had experienced a crash on the road rated it more likely for a crash happening on the road in general than the majority of the drivers who had not. Could this mean that crash history impacted the participants' utility based risk perception? Perhaps so, but the number of participants who had experienced a crash on the target roads was very small, which made a statistical comparison unsuitable.

4.1.5 Individual Differences in Speed Preferences and Speed Variability

As was seen in the large standard deviations (and wide confidence intervals) for all the speed preference measures, drivers preferred very different speeds to one another. Large individual differences were also indicated by the diversity in the participants' speed ratings and in their observed speeds. That large individual differences were associated with speed preference was not surprising in light of a similar finding made in Goldenbeld and van Schagen's (2007) experiment, where large standard deviations were also observed.

When analysing the large spread of answers in the dataset from Goldenbeld and van Schagen's experiment Elvik (2010) found that differences in speed preference may be a potent source in explaining speed variability and speed conflicts on the road. The results in this study would similarly suggest that individual differences with regard to speed preference may lead to conflicts between drivers. An illustration of a potential conflict was given by one

participant who said: “I like to drive 60 no matter what the speed limit is. It is the speed where I am most alert and drive the best”. This example illustrates a point made by Elvik (2010) that a small number of drivers may determine the traffic flow and mean driving speeds of many other drivers. Consequently, because of the large individual differences in speed preference conflicts such as queues, tailgating, and dangerous overtaking may be likely to occur.

Elvik (2010) suggested that the interaction between drivers depends on how sensitive they are towards each other's speeds. For example, a driver who is very sensitive towards the speed of another vehicle may decide to follow rather than overtake; whereas a driver who is not very sensitive towards the speed of another vehicle may decide to overtake. The results on speed consistency in this study would support the idea that speed sensitivity may affect driver interactions. With regard to sensitivity, the results on speed consistency suggested that while drivers' speed preferences are stable, they are also a little flexible (as seen in that most drivers' speeds varied less than a 10%). Perhaps one could refer to this flexibility as a speed preference range. In that regard, one could perhaps suggest that differences in drivers' speed preference ranges are related to their sensitivity towards the speed of other drivers. A hypothesis of speed preference ranges would for example propose that a driver will be more likely to overtake or tailgate another vehicle if that vehicle is travelling at a speed which is lower than the pursuing driver's speed preference range.

There were also some differences between the results reported by Elvik (2010) and those found in this study. Elvik (2010) found that two groups of drivers were represented on the road: the slow movers (who preferred 80 km/h) and the fast movers (who preferred 100 km/h). In this study, it seemed that drivers

preferred more diverse speeds than the two ‘speed groups’ identified by Elvik (2010). Perhaps this was most clearly seen in the results on speed consistency. On Ruakura Road b, where 37 vehicles were measured repeatedly, their speeds did not cluster around two different speeds (80 km/h and 100 km/h), but rather a linear relationship was found. This would indicate that (when observed in traffic) drivers’ speeds are uniquely different to each other. It could be that the results differed because of the difference in methodology. In Goldenbeld and van Schagen’s (2007) experiment drivers had been asked what a safe speed limit would be, and the majority had consequently answered either 80 km/h or 100 km/h (Elvik, 2010). However, in this study actual driving speeds were observed, and it could be that this measure was more sensitive in picking up individual differences in speed preference. If so, then perhaps having an objective measure of speed preference (such as ‘a vehicle’s observed speed difference to the speed limit when travelling at free speed’) could be a useful measure of speed preference. While the two distinct groups (fast and slow movers) were not found in this study, the results on speed consistency did indicate that some drivers do indeed seem to prefer faster speeds while some prefer slower speeds.

4.1.6 Insight on Risk Perception

In light of the two classic risk perception theories introduced in the literature review above (Summala, 1988; Wilde, 1986) which both suggested that risk perception would influence speed, one could have expected that there would have been a greater relationship between speed preference, speed choice and risk perception in this study also. Perhaps the lack of relationship between risk perception on speed rating and speed preference was due to the way risk

perception was measured. The three questions measuring risk perception in this study were all worded in a way which defined risk perception as a utility assessment skill, a task which people have been found do poorly (Elvik, 1010; Howarth, 1988).

The lack of relationship between risk perception and speed preference did not, however, mean that drivers were unaware of risks. The high number of comments from participants on the topic of risk and crash likelihood indicated that participants were aware of risk factors. Comments such as: “Heavy traffic makes it extremely risky” and “how safe the road is depends on the weather, and on other drivers” suggest that drivers regarded riskiness as something which was dependent on a number of changing circumstances (i.e. pedestrians, cyclists, roundabouts, intersections, traffic volume, time of day, driver awareness, to name a few of the factors that were mentioned by the participants). In fact, the high number of momentary risk factors that were spontaneously mentioned by the participants would suggest that drivers’ ascribed more danger to these than to the road itself. Such a notion would be consistent with theories which have suggested that drivers will perceive more risk from circumstances that impede travel (Brenda & Hoyos, 1983) rather than from road features which remain the same (Armsby et al., 1989, Damasio, 1994).

Another finding related to risk perception was that roads that were very similar in layout and design (such as Cobham Drive and Wairere Drive) were not rated the same in terms of riskiness. Road familiarity could be one explanation for the observed difference between these two roads (as most of the participants at Cobham Drive were tourists; and the participants who referred to Wairere Drive were travelling to work). Another explanation for the observed difference could

be that there despite many similarities also were some differences between the two roads. For example, Wairere Drive is newer, straighter, flatter and wider than Cobham Drive; and curvature, lateral position (Kanellaidis, Zervas, & Karagioules, 2000) and lane-width (Lewis-Ewans & Chartlon, 2006) are factors that have in some cases been found to influence risk perception.

4.2 Limitations

The answer to the first research question (can speed preference help explain actual driving speeds?) would perhaps have been even clearer had observed speed data been available for all the participants in the questionnaire (available for nine participants only). Factors which made this task challenging were: traffic volume, traffic density, lack of daylight when drivers arrived for work, and organizing extra assistants for data collection times.

Another challenge was getting large numbers of participants to refer to the same sections of the roads. Some participants referred to other sections of the road (such as commuters referring to the open rural road). Because of this, these participants were solely included in the analyses which were based on questionnaire data alone; which meant that some statistical power was lost. A similar challenge was that at one location, Ohaupo Road, it was not suitable to obtain speed gun measures in the 60 km/h zone that most of the participants were referring to, but rather in the 70 km/h zone right before it. Consequently, it was not obtained observed speed measures from the exact location that participants were referring to.

As many of the findings in this study were obtained from a questionnaire, one could ask whether those who willingly participated in the questionnaire

represent an unbiased sample of the population (Nardi, 2003). It may in this case have been helpful that the participants at the different survey locations also represented very different demographic backgrounds.

One could also ask whether the presence of a researcher may have meant that some participants wanted to portray themselves in a good light. In light of the finding of an optimism bias, this is a possibility. However, it is believed that the benefits of verbally administering the questionnaires outweighed the disadvantages (such as having an increased response rate and better quality in the participants' answers).

Due to the lack of relationship between risk perception and speed preference, one could ask whether the questions in the questionnaires served as good measures of risk perception. It would appear that the questions on risk perception better represented the utility assessment side of risk perception, which one perhaps could better describe as risk assessment.

4.3 Implications and Suggestions for Further Research

If speed preference effectively explains part of the occurrence of speed variability, then making drivers prefer similar speeds would seem to be an important question to answer. So, how do you make drivers prefer the same speeds? One approach has been to make speed limits that are credible (or appropriate) to the majority of drivers, and to design road environments which better fit the posted speed limits (Goldenbeld & van Schagen, 2007). The results in this study would similarly suggest that road design seemed to affect drivers' speed preferences, and thus also the credibility of a speed limit. Consequently, creating road environments that clearly communicate to drivers what the appropriate or optimal speed is would

potentially reduce speed variability (and danger) in traffic. Moreover, if driving speeds occur somewhat habitually (and without awareness), then controlling speeds by the means of road design would potentially be an effective addition to traditional ways of informing drivers of the speeds they should select.

If, on the other hand, drivers' speed preferences are not easily changed then an alternative way of increasing traffic safety may be to accommodate for the differences in drivers' speed preference. For example, one way of reducing the risks associated with speed variability may be in the development of driver aid technology which is sensitive towards changes in speed variability. Similarly one could suppose that having dual lanes in each direction would give drivers the opportunity to choose speeds that match their personal preference. However, dual lanes are not necessarily a safer option, as was pointed out by Navon (2003) who suggested that a driver with a preference for very high speeds may perform hazardous overtaking even in a two-lane road system. This relates to Elvik's (2010) idea of drivers' sensitivity towards other drivers' speed choices; an idea which in this study was referred to as speed preference ranges. An interesting investigation for future research would be to look at the relationship between risky driver behaviours (such as short following distances, and dangerous overtaking) and the size of drivers' speed preference ranges. Perhaps drivers' speed preference ranges (or speed choice sensitivity) may help explain two very common yet risk prone driver behaviours, namely overtaking and tailgating.

4.4 Conclusion

In conclusion, in this study support was found for a relationship between speed preference and speed choice. Drivers' speed preferences were seen to be

consistent, somewhat speed limit resilient, and most importantly to influence their actual driving speeds. Consequently, speed preference likely explains some of the speed variability observed on roads today, chiefly because drivers have different driving goals and because there are large individual differences with regards to what speeds they prefer. Finding ways of accommodating for driver differences may decrease some of the risks associated with speed variability. Yet, it is argued here that finding ways of making drivers prefer similar speeds may have a great potential to reduce speed variability and thus increase traffic safety.

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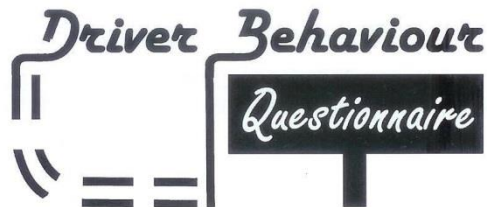
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Appendices

Appendix A

VR Code: _____


ID# 110




Introduction

Hello. I am doing my masters (or: I am doing a survey on behalf of a masters-student) at the University of Waikato, and today I am inviting drivers to participate in a questionnaire. Would you be interested in participating?

First, let me give you some brief information about it. The main goal of the questionnaire is to explore what motivates drivers to drive at different speeds. The questionnaire will take about 3 minutes to complete; and to thank you for your participation you will receive a chocolate bar. All information will be treated in the strictest confidence, in accordance with the ethical guidelines at the University. This study has been approved by the School of Psychology's Ethics Committee. If you wish to participate, you have the right to withdraw at any time and for any reason, without losing your reward for participating, and you are not obligated to answer all the questions in the questionnaire. You are also most welcome to ask any questions you might have.

Consent	
 THE UNIVERSITY OF WAIKATO <small>Ti Whare Wānanga o Waikato</small>	<p>After hearing the above information,</p> <p>do you consent to participate?</p> <p><input type="checkbox"/> Yes</p>
<p>If yes, the participants initials _____</p>	


TARS
Traffic and Road Safety Research Group

VR Code: _____

ID# 110

Section 1: About the driver

- ☐ Male
☐ Female

Age: _____ years

- ☐ Full
☐ Restricted
☐ Learner

Section 2: How fast were you going?

Question: 2. A Which way did you come in (e.g. [name of road])? _____

Question: 2. B _____ km/h

What was your speed on _____? ☐ Don't know

Section 3: How fast would you like to go?

Question 3. A

What speed would you choose on _____ km/h
_____, if your primary goal is to drive safely? ☐ Don't know

Question: 3. B

What speed would you choose _____ km/h
on _____, if your primary goal is to save money on fuel? ☐ Don't know

Question 3. C

What speed would you choose on _____ km/h
_____ to maximise the fun of driving? ☐ Don't know

Question 3. D

What speed do you usually drive at on _____ km/h
_____? ☐ Don't know

Question: 3.E

What is the legal speed limit on that section of _____? ☐ Don't know

VR Code: _____

ID# 110

Section 4: Riskiness Assessments

Question: 4. A

On a scale of 1-10 (1 being 'not risky', 10 being 'extremely risky') how risky would you rate _____?

1 2 3 4 5 6 7 8 9 10

Question: 4. B

What is the likelihood of a crash happening on _____?

- ☐ Extremely likely
- ☐ Likely
- ☐ Neither likely or unlikely
- ☐ Unlikely
- ☐ Extremely unlikely

Question: 4. C

What is the likelihood of a crash happening to you on _____?

- ☐ Extremely likely
- ☐ Likely
- ☐ Neither likely or unlikely
- ☐ Unlikely
- ☐ Extremely unlikely

Question: 4. D

Have you ever been in a crash on that road?

- ☐ Yes
- ☐ No

Question: 5. A

Have you had any speeding tickets on that on that road and in the last 12 months?

- ☐ Yes
- ☐ No

Question: 5. B

If yes, how many? _____ number of speeding tickets

That is the end of this questionnaire.

Thank you very much for your time and for your answers!

For more information, please check out the information pamphlet.

Appendix B

Speed Data Collection Sheet (Used at vehicle speed detection site)

Location: _____ Date: _____ Time of day: _____:_____:_____ to _____:_____:_____

#	LICENCE PLATE (3 first letters)	COLOUR	TYPE (e.g. 2- door)	RANGE (meters)	SPEED (km/h)
V1					
V2					
V3					
V4					
V5					
V6					
V7					
V8					
V9					
V10					
V11					
V12					
V13					
V14					
V15					
V16					
V17					
V18					
V19					
V##					

Appendix C

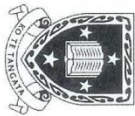
Vehicle Recognition Sheet (Used at questionnaire site)

Location: _____ Date: _____ Time of day: ____:____ to ____:____

VR Code	LICENCE PLATE (3 first letters)	COLOUR	TYPE (e.g. 2-door)	Admin (yes/no)
VR1				
VR2				
VR3				
VR4				
VR5				
VR6				
VR7				
VR8				
VR9				
VR10				
VR11				
VR12				
VR13				
VR14				
VR15				
VR16				
VR17				
VR18				
VR19				
VR20				
VR##				

Appendix D

*Thank you for
your
participation!*



THE UNIVERSITY OF
WAIKATO
Toitangi Whangā o Waikato



Information Pamphlet

About this research

This research is the part of a master student's thesis, and it is partly supported by and completed under the supervision of the Traffic and Road Safety (TARS) Research Group at the University of Waikato.

The main goal of this questionnaire is to explore why drivers prefer such different speeds to one another, and this is done by asking drivers about their attitudes and behaviour on the road.

The questionnaire will take about 3 minutes to complete, and participants will receive a chocolate bar as thanks for their time and answers.

This study has received Ethics Approval from the School of Psychology's Ethics Committee. All information obtained in

this questionnaire will be kept in the strictest confidence and all answers will be completely anonymous.

Participants have the right to withdraw at any time and for any reason without losing their reward for participating, and participants are not obligated to answer all the questions in the questionnaire.

The data obtained in this study will be used for the student's master thesis, and the results of this research will be published on the University of Waikato Research Commons website when this research is completed mid-year 2014.

If you would like some more information about this research, or if you have any concerns about the conduct of this research, you are most welcome to get in touch.

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